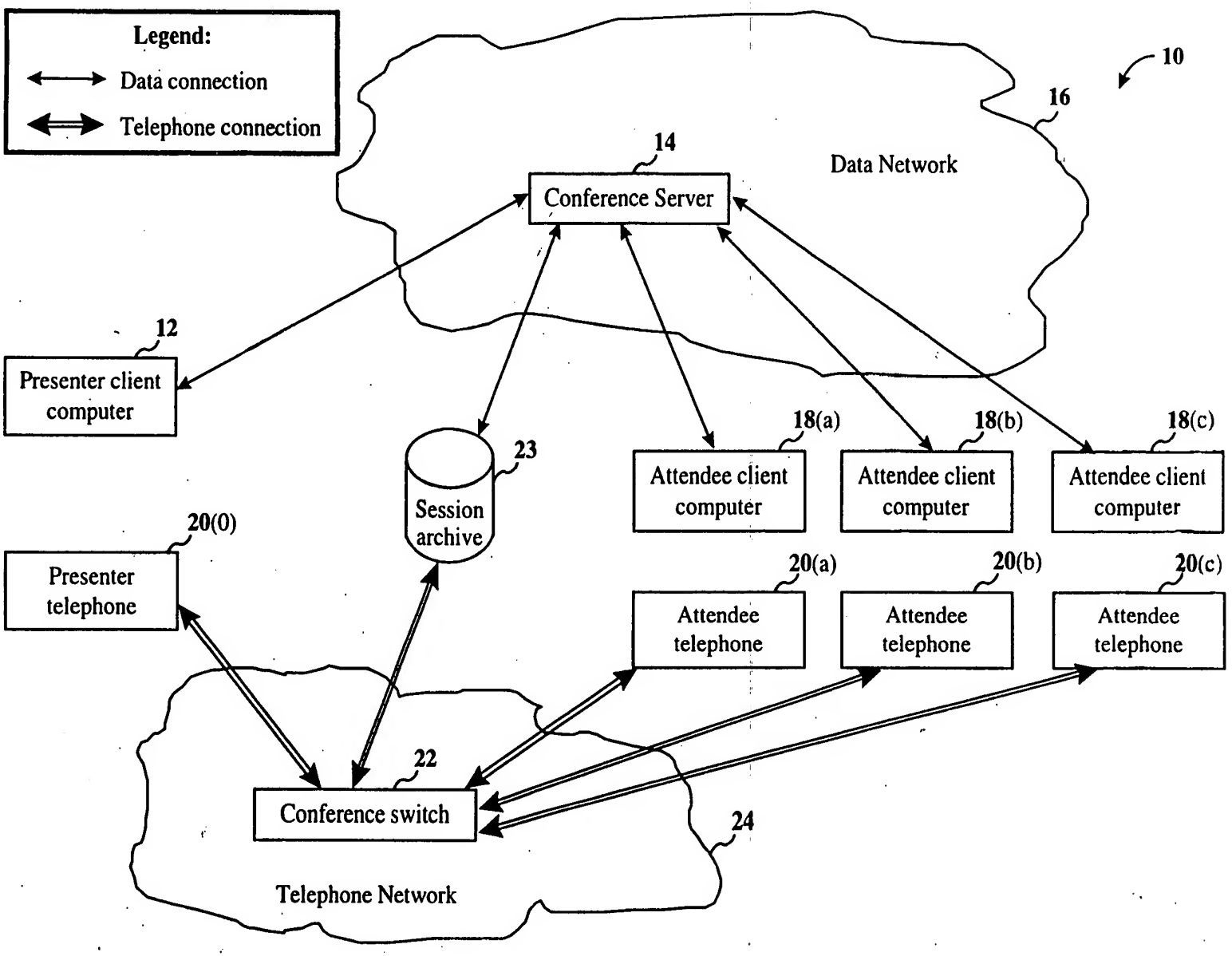

Legend:
Data connection
Telephone connection
10
16
Data Network
14
Conference Server
12
Presenter client computer
23
Session archive
18(a)
18(b)
18(c)
Attendee client computer
Attendee client computer
Attendee client computer
20(0)
Presenter telephone
20(a)
20(b)
20(c)
Attendee telephone
Attendee telephone
Attendee telephone
22
Conference switch
24
Telephone Network

FIG. 1

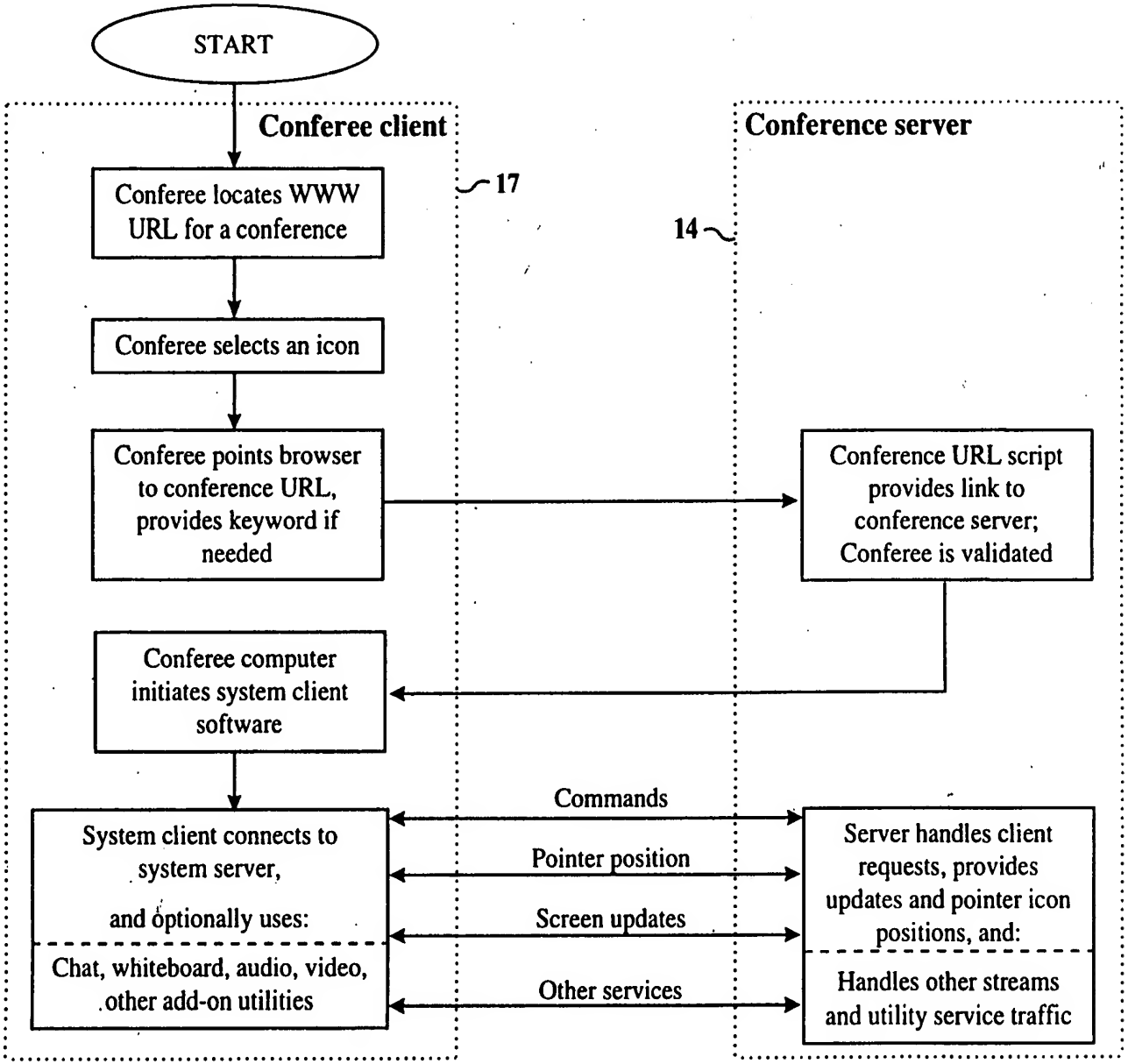

START
Conferee client
17
Conference server
14
Conferee locates WWW URL for a conference
Conferee selects an icon
Conferee points browser to conference URL, provides keyword if needed
Conference URL script provides link to conference server; Conferee is validated
Conferee computer initiates system client software
Commands
Pointer position
Screen updates
Other services
System client connects to system server,
and optionally uses:
Chat, whiteboard, audio, video, other add-on utilities
Server handles client requests, provides updates and pointer icon positions, and:
Handles other streams and utility service traffic

FIG. 2

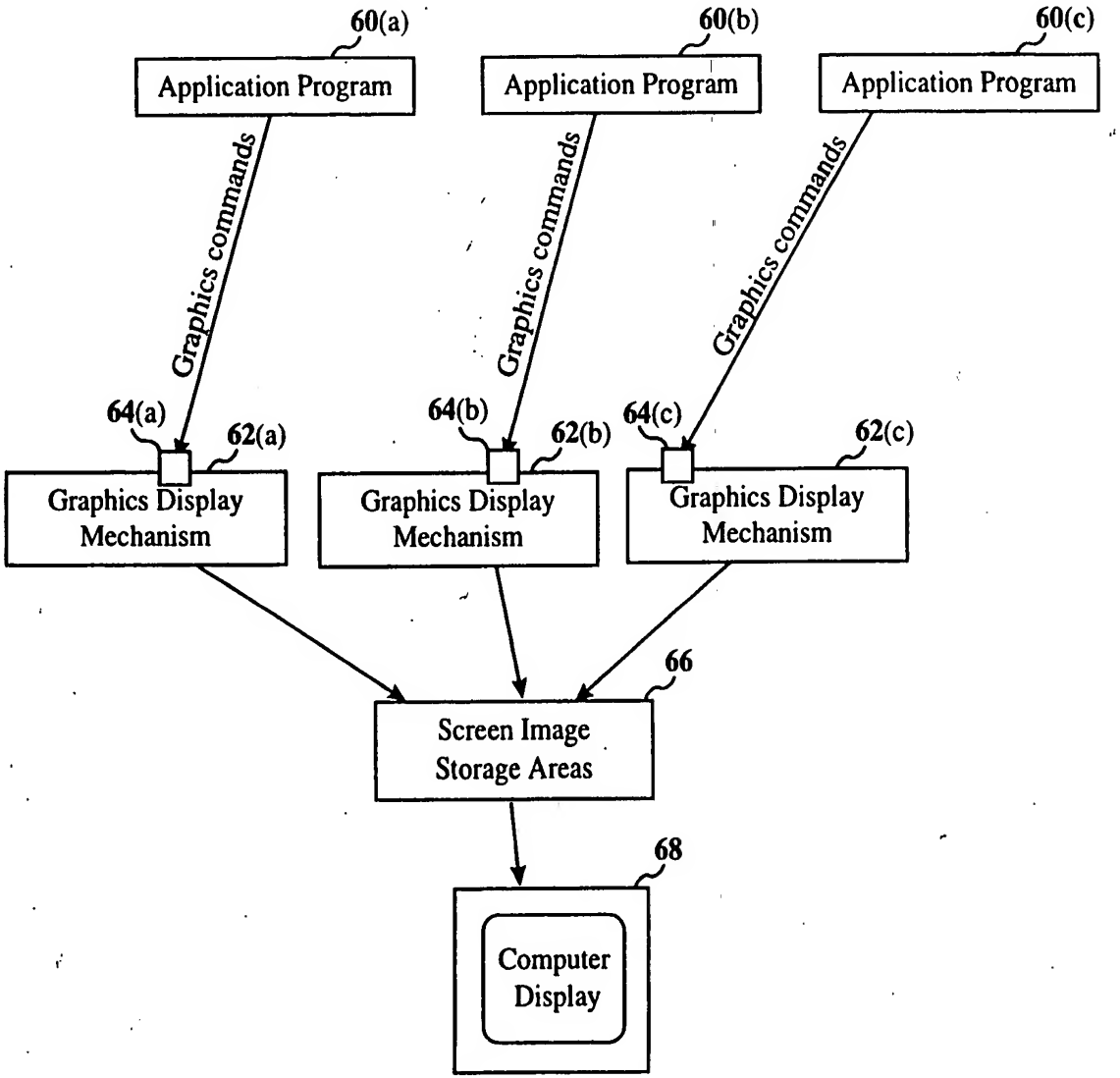

60(a)
Application Program
60(b)
Application Program
60(c)
Application Program
Graphics commands
Graphics commands
Graphics commands
64(a)
62(a)
64(b)
62(b)
64(c)
62(c)
Graphics Display Mechanism
Graphics Display Mechanism
Graphics Display Mechanism
66
Screen Image Storage Areas
68
Computer Display

FIG. 3

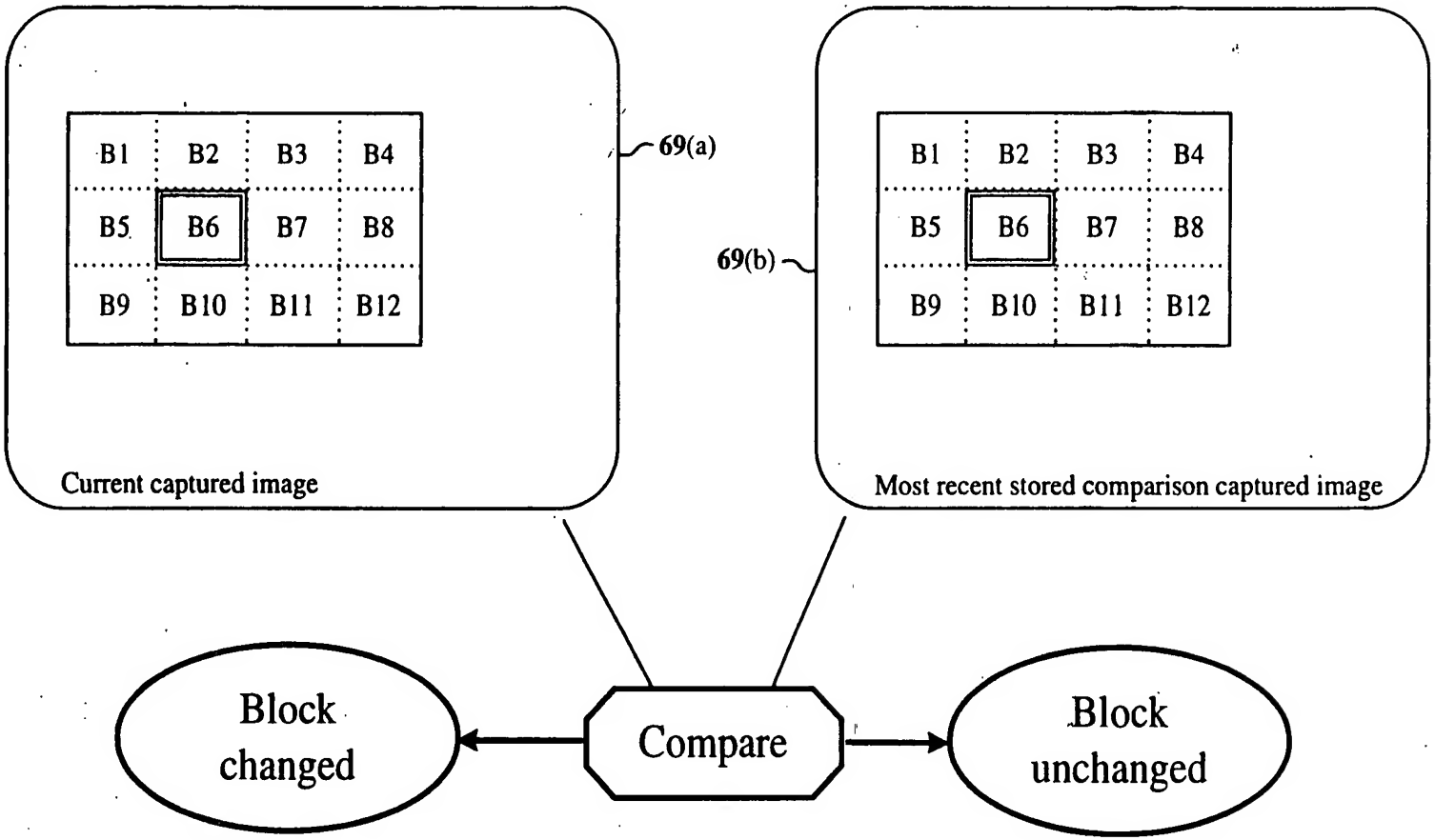

B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
69(a)
69(b)
Current captured image
Most recent stored comparison captured image
Block changed
Compare
Block unchanged

FIG. 4A

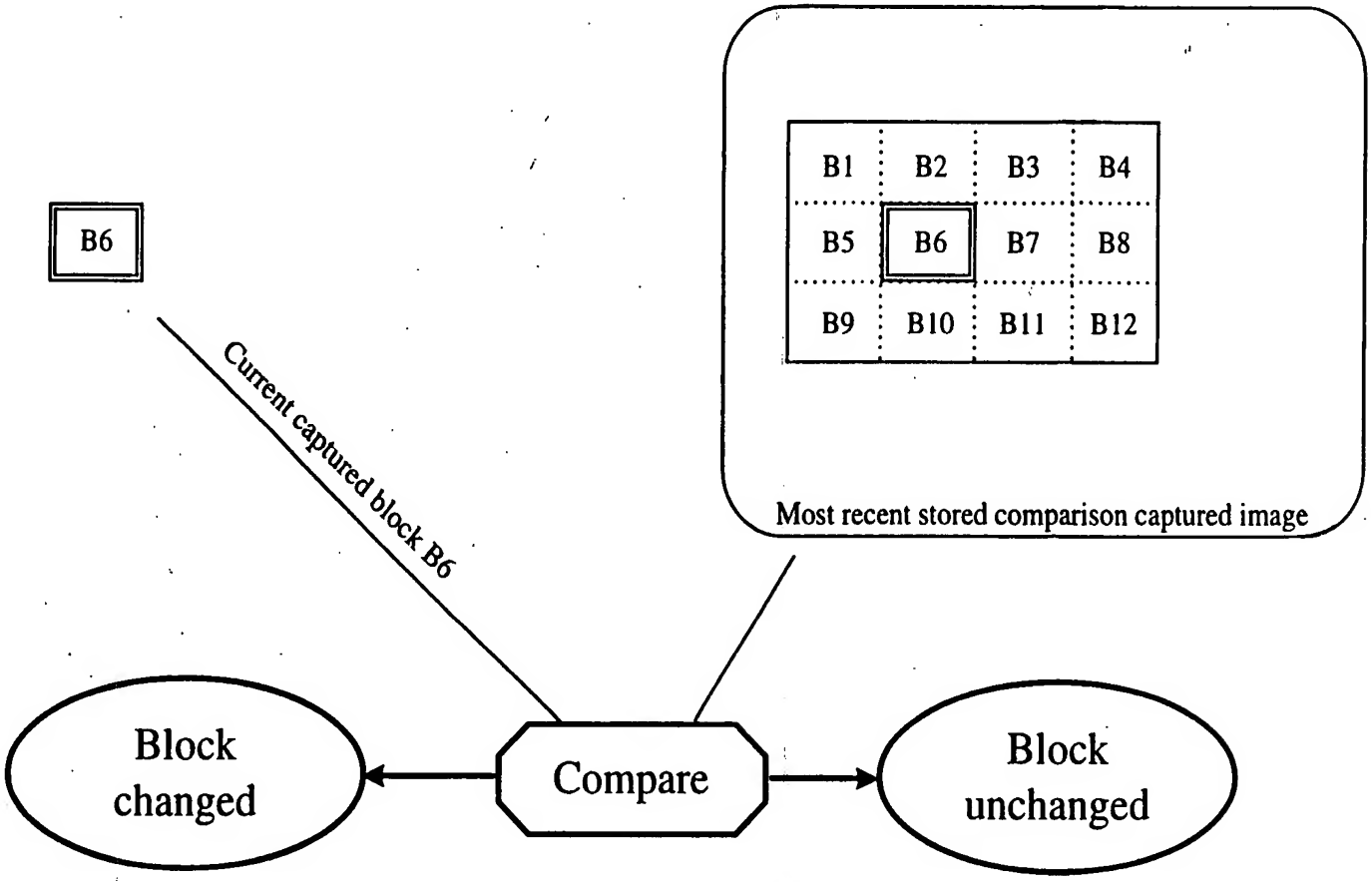

B6
Current captured block B6
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
Most recent stored comparison captured image
Block changed
Compare
Block unchanged

FIG. 4B

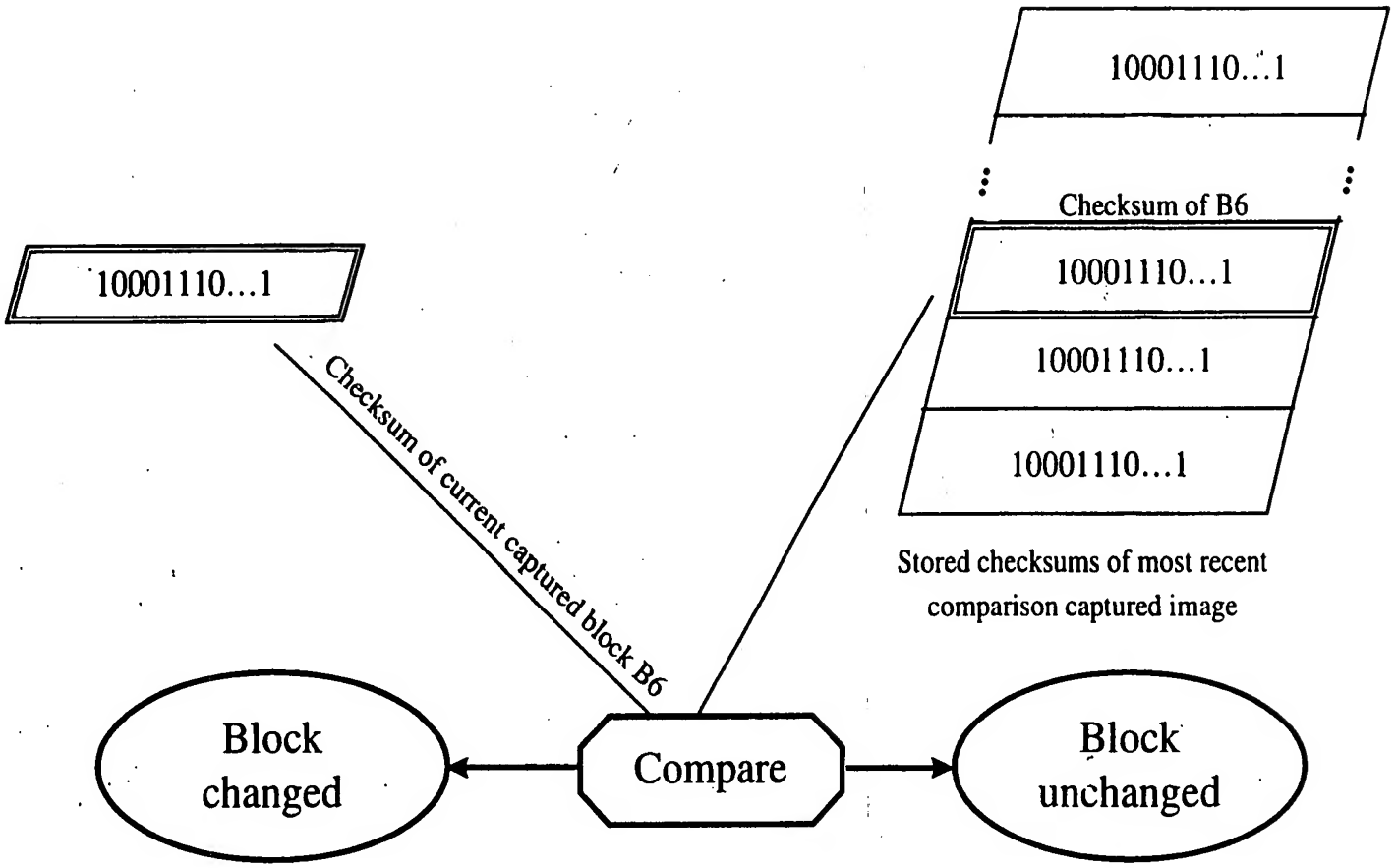

10001110...1
Checksum of B6
10001110...1
10001110...1
10001110...1
Stored checksums of most recent comparison captured image
10001110...1
Checksum of current captured block B6
Block changed
Compare
Block unchanged

FIG. 4C

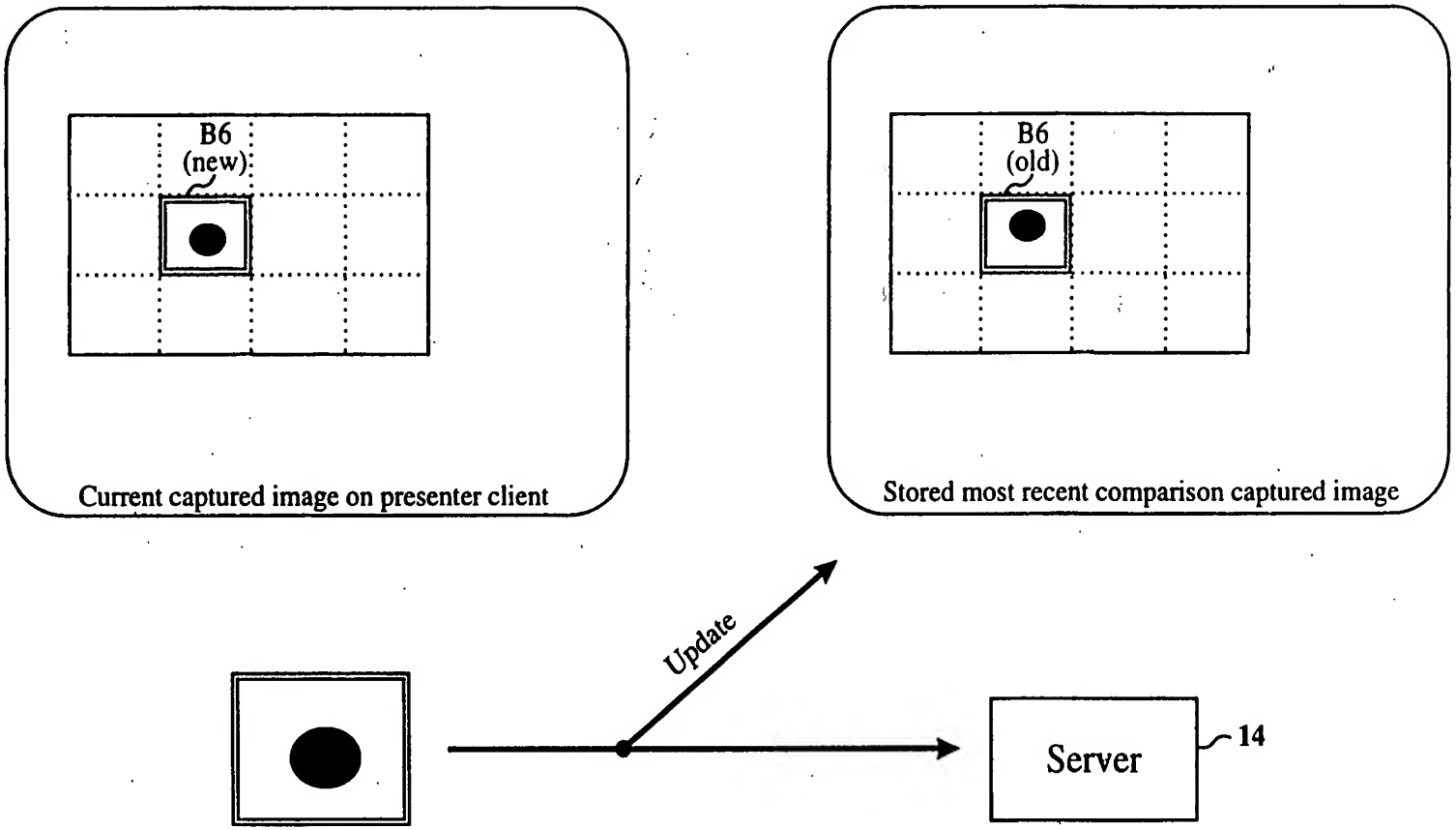

B6
(new)
Current captured image on presenter client
B6
(old)
Stored most recent comparison captured image
Update
Server
14

FIG. 4D

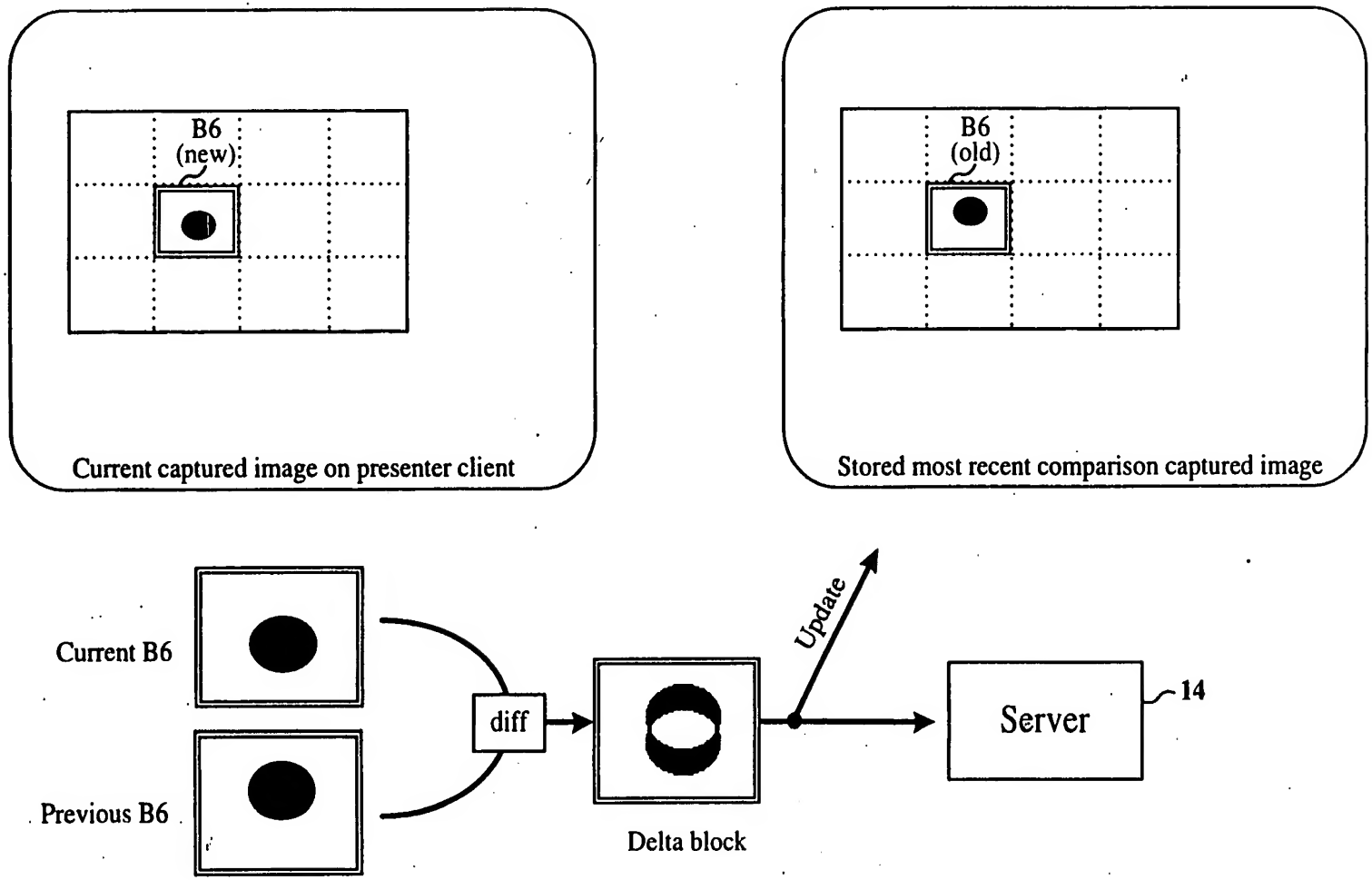

B6
(new)
Current captured image on presenter client
B6
(old)
Stored most recent comparison captured image
Current B6
Previous B6
diff
Delta block
Update
Server
14

FIG. 4E

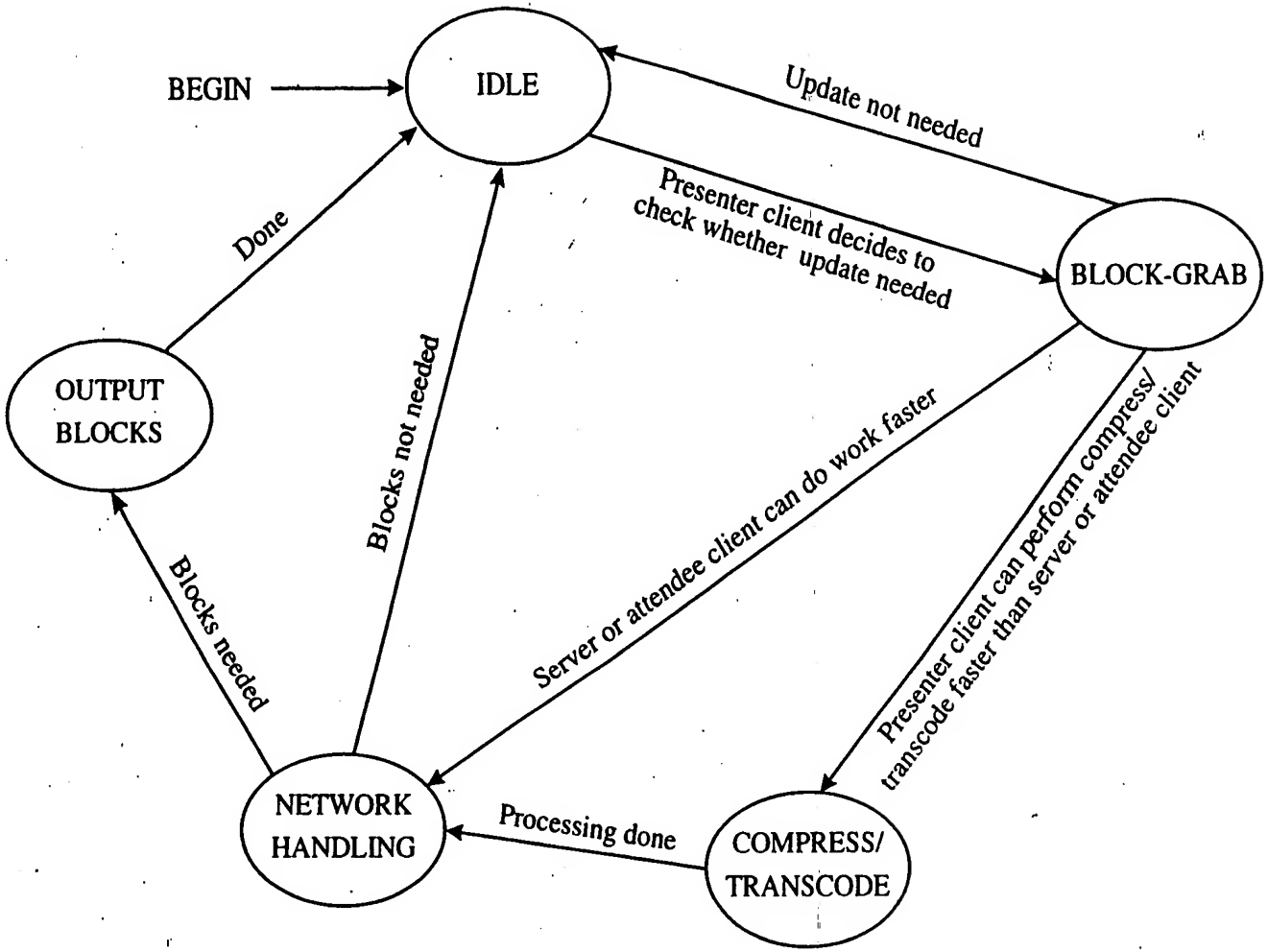

BEGIN
IDLE
Update not needed
Presenter client decides to check whether update needed
BLOCK-GRAB
Done
OUTPUT BLOCKS
Blocks not needed
Server or attendee client can do work faster
Presenter client can perform compress/ transcode faster than server or attendee client
Blocks needed
NETWORK HANDLING
Processing done
COMPRESS/ TRANSCODE

FIG. 5

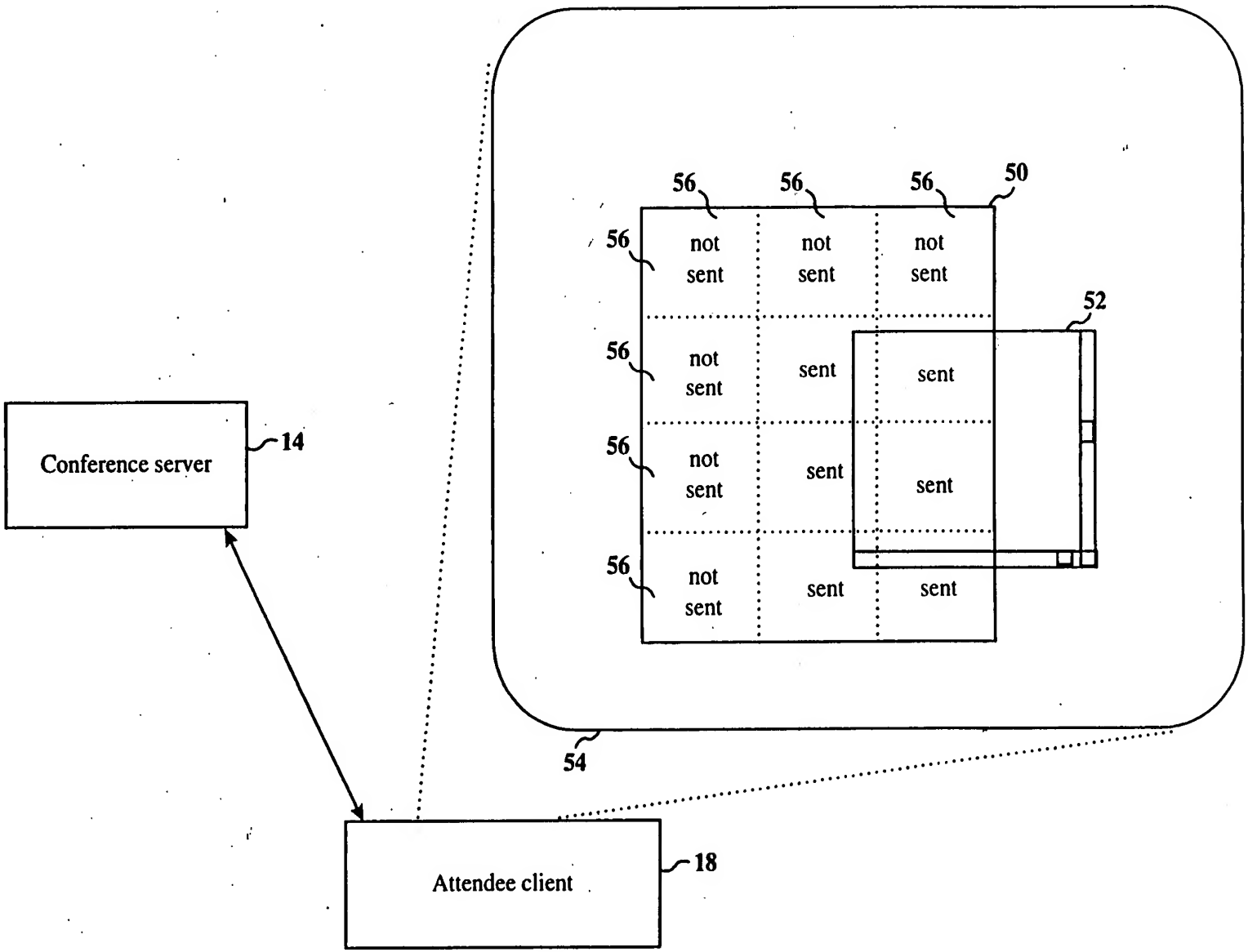

Conference server
14
Attendee client
18
54
50
52
56
not sent
sent

FIG. 6A

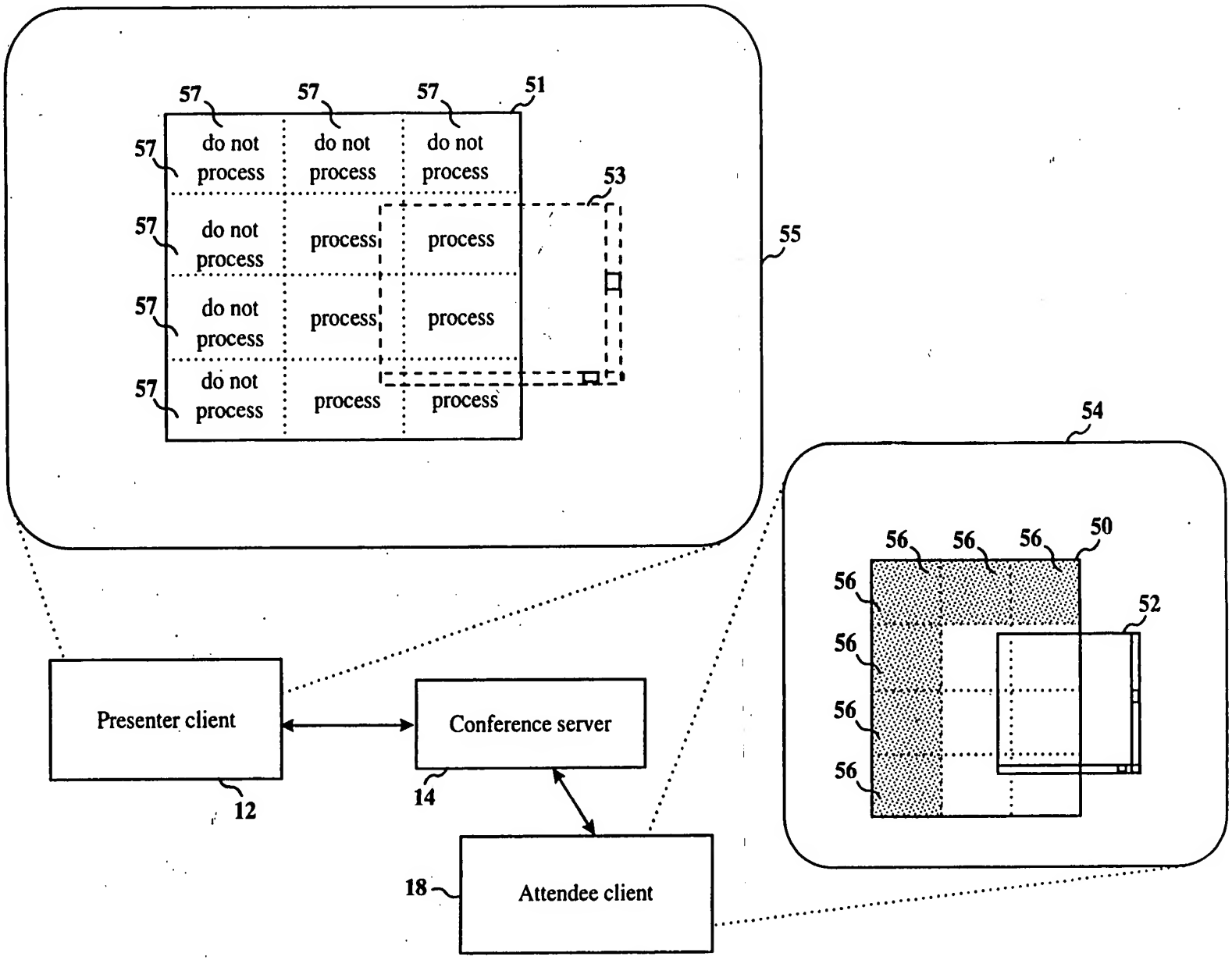

57
57
57
51
do not process
do not process
do not process
53
55
process
process
process
process
process
54
56
56
56
50
52
Presenter client
Conference server
12
14
18
Attendee client

FIG. 6B

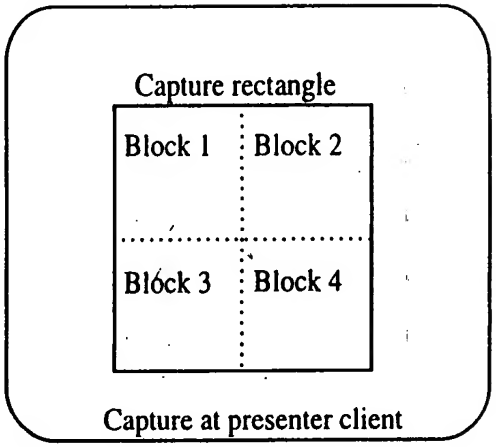


Illustration of the effect of specifying consistency at the attendee client			
(other delays in displaying assumed to be caused by loading at client)			
Time order	**Received at client**	**Displayed by client**	
		Consistency OFF	Consistency ON
1	Block 1		
2	Block 2	Block 1	
3	Block 3	Block 2	
4	Block 4	Block 3	
5	...	Block 4	Blocks 1-4
6	...	...	...

FIG. 7A

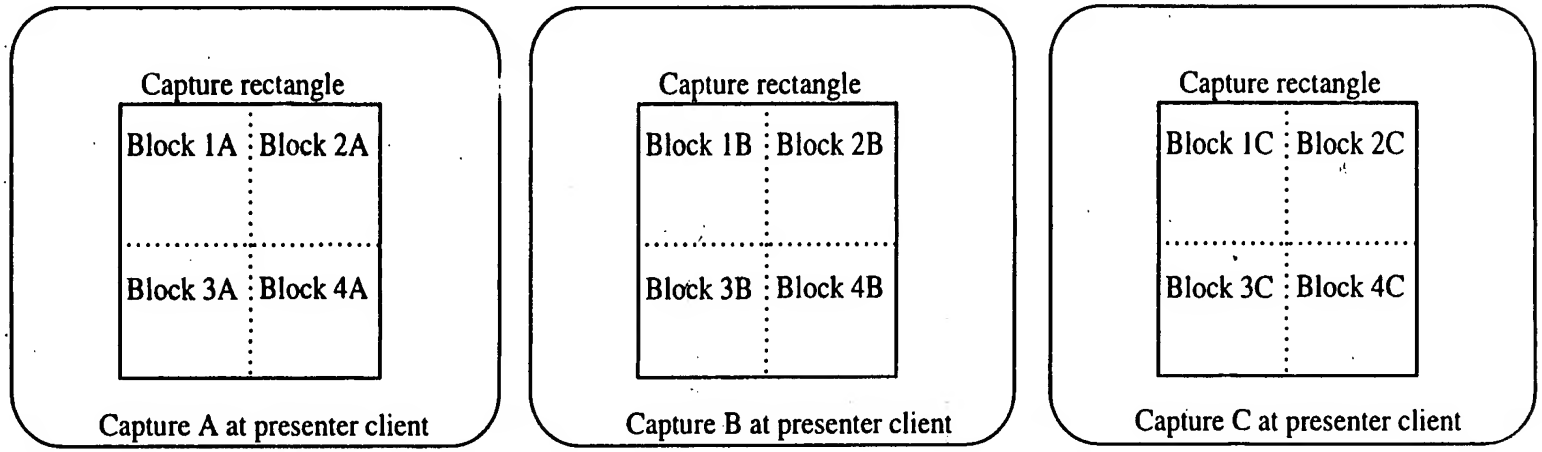


Illustration of the effect of specifying consistency at the server

(other delays in sending assumed to be caused by loading at attendee client)

Time order	Received by server	Sent by server	
		Consistency OFF	Consistency ON
1	Block 1A		
2	Block 2A		
3	Block 3A	Block 1A	Block 1A
4	Block 4A		
5	Block 1B		
6	Block 2B	Block 2A	Block 2A
7	Block 3B		Block 3A
8	Block 4B	Block 3B	
9	Block 1C	Block 4B	Block 4A
10	...	Block 1C	Block 1B
11	...	...	...

FIG. 7B

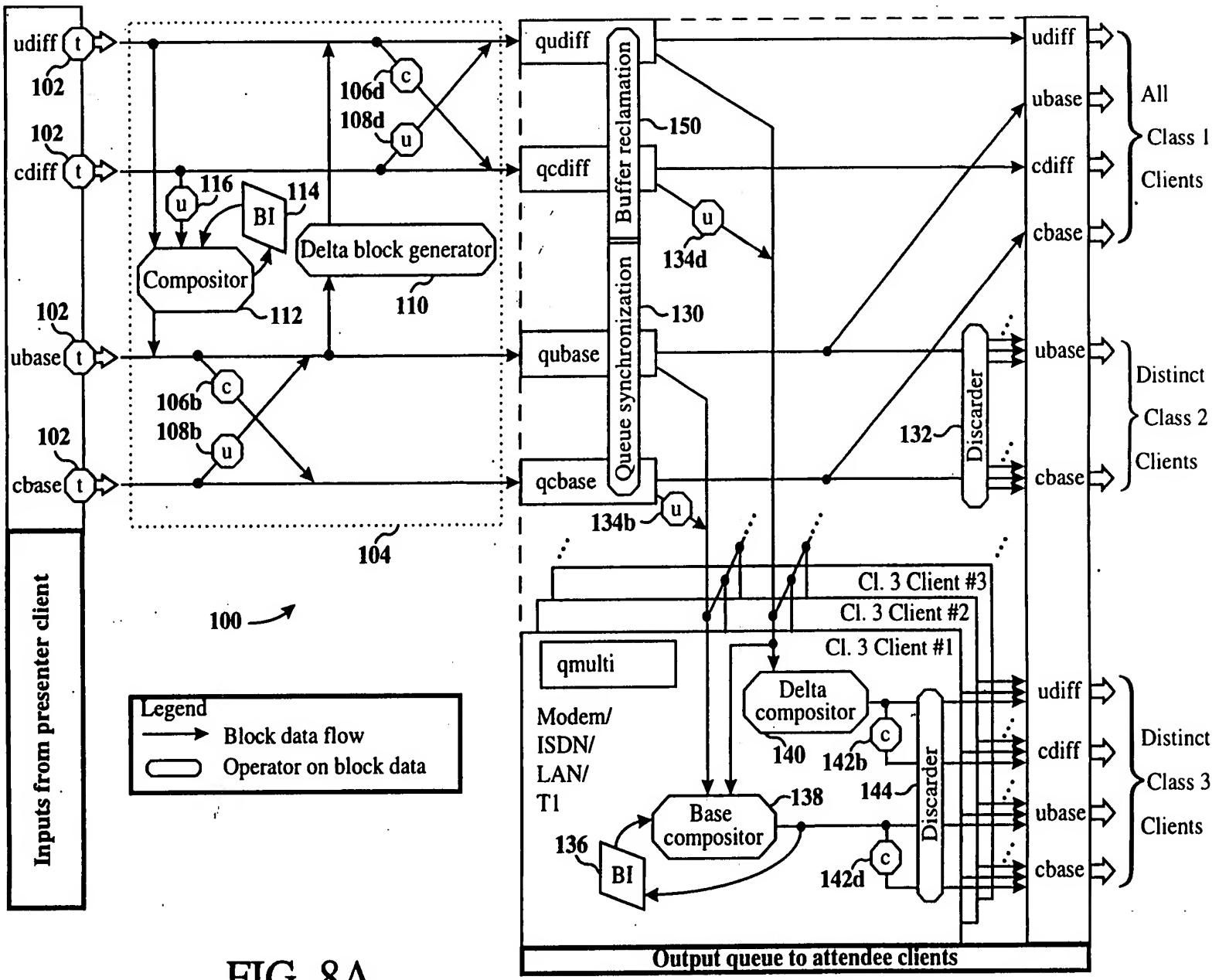

udiff
cdiff
ubase
cbase
102
t
u
c
106d
108d
106b
108b
116
114
BI
Compositor
112
Delta block generator
110
104
100
Inputs from presenter client
qudiff
qcdiff
qubase
qcbase
Buffer reclamation
150
Queue synchronization
130
134d
134b
Discarder
132
udiff
ubase
cdiff
cbase
All
Class 1
Clients
Distinct
Class 2
Clients
Distinct
Class 3
Clients
Cl. 3 Client #3
Cl. 3 Client #2
Cl. 3 Client #1
qmulti
Modem/
ISDN/
LAN/
T1
Delta
compositor
140
142b
144
Base
compositor
138
136
142d
Output queue to attendee clients
Legend
Block data flow
Operator on block data

FIG. 8A

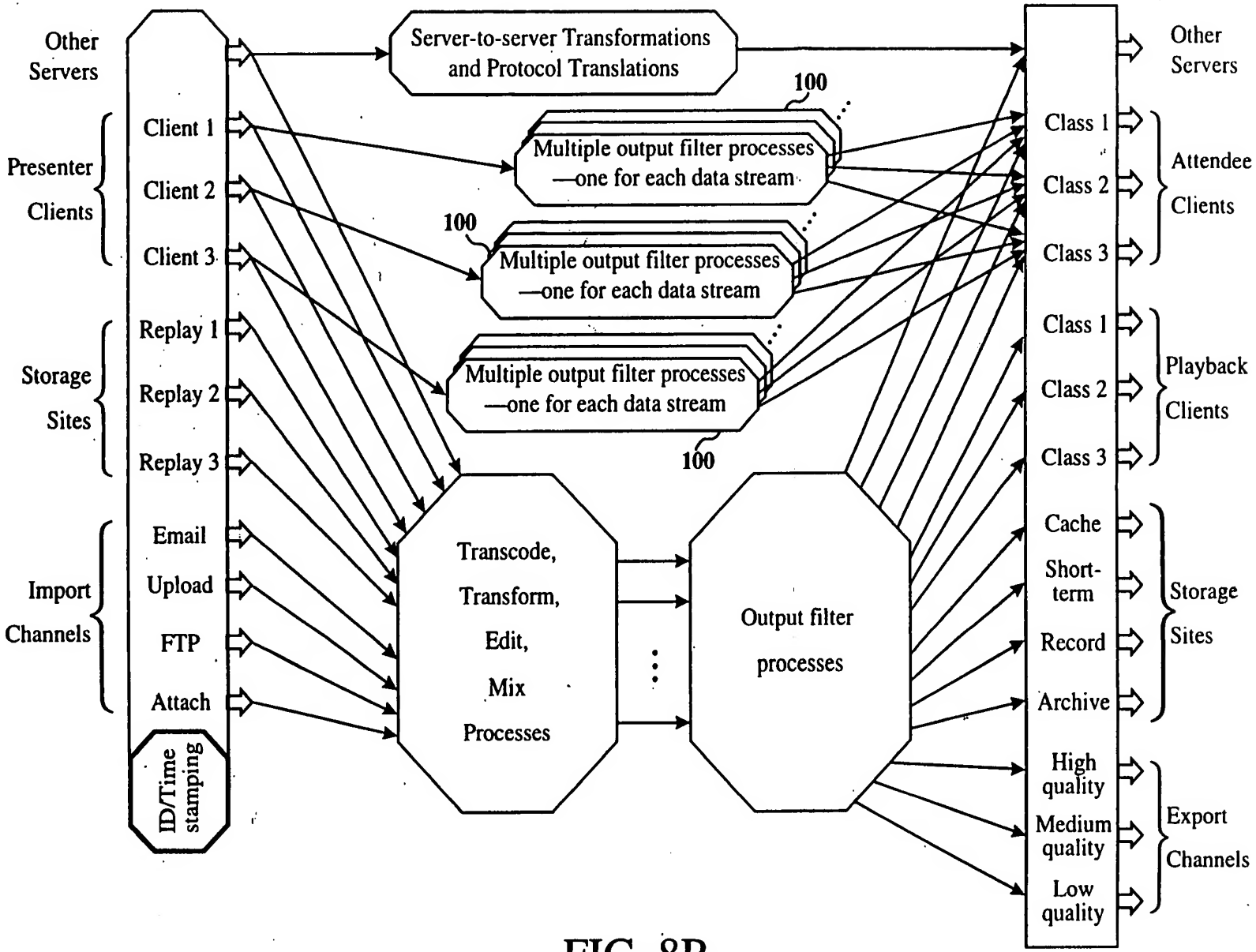

Other Servers
Presenter Clients
Client 1
Client 2
Client 3
Storage Sites
Replay 1
Replay 2
Replay 3
Import Channels
Email
Upload
FTP
Attach
ID/Time stamping
Server-to-server Transformations and Protocol Translations
100
Multiple output filter processes —one for each data stream
100
Multiple output filter processes —one for each data stream
Multiple output filter processes —one for each data stream
100
Transcode, Transform, Edit, Mix Processes
Output filter processes
Other Servers
Class 1
Class 2
Class 3
Attendee Clients
Class 1
Class 2
Class 3
Playback Clients
Cache
Short-term
Record
Archive
Storage Sites
High quality
Medium quality
Low quality
Export Channels

FIG. 8B

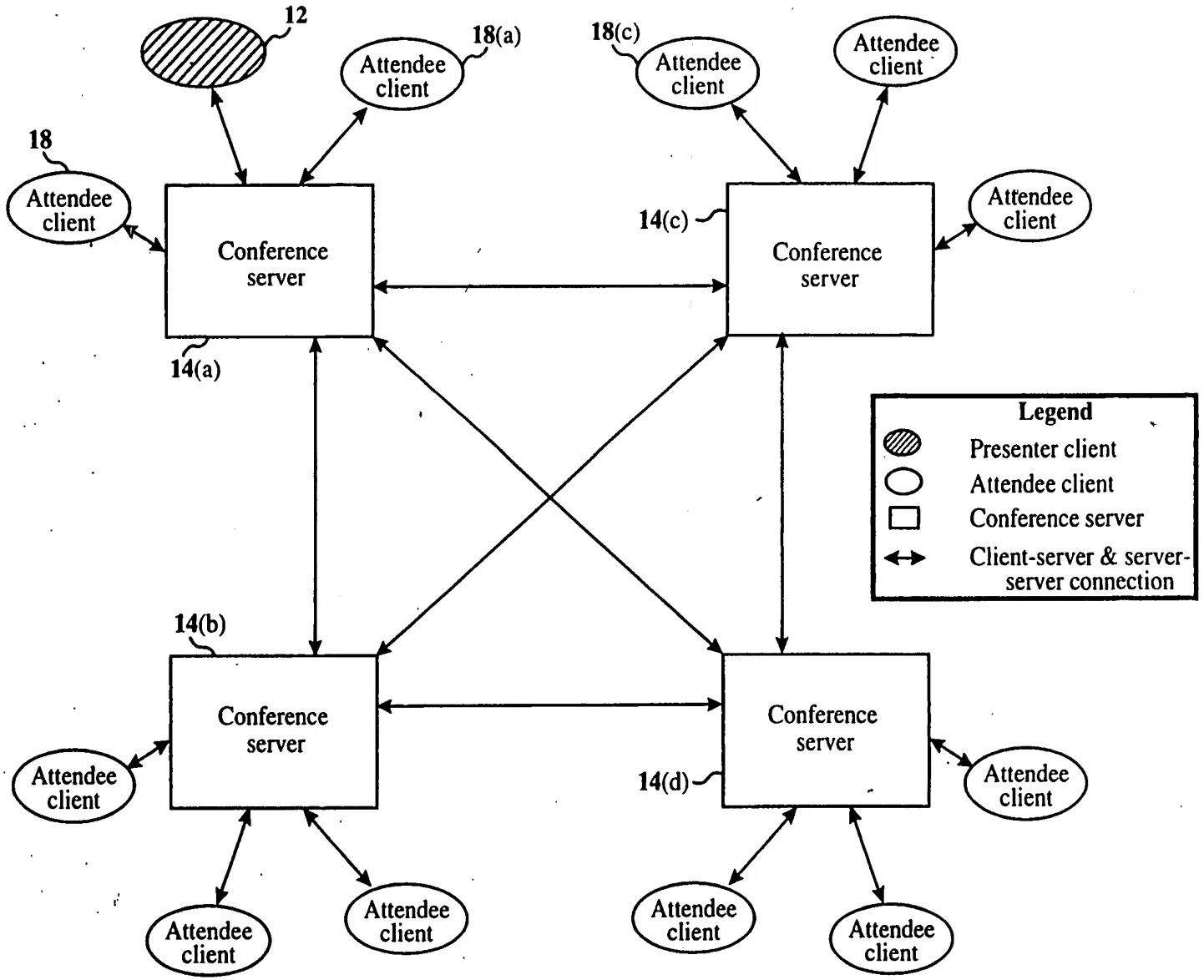

12
18(a)
Attendee client
18(c)
Attendee client
Attendee client
18
Attendee client
Conference server
14(c)
Conference server
Attendee client
14(a)
Legend
Presenter client
Attendee client
Conference server
Client-server & server-server connection
14(b)
Conference server
Conference server
Attendee client
14(d)
Attendee client
Attendee client
Attendee client
Attendee client

FIG. 9A

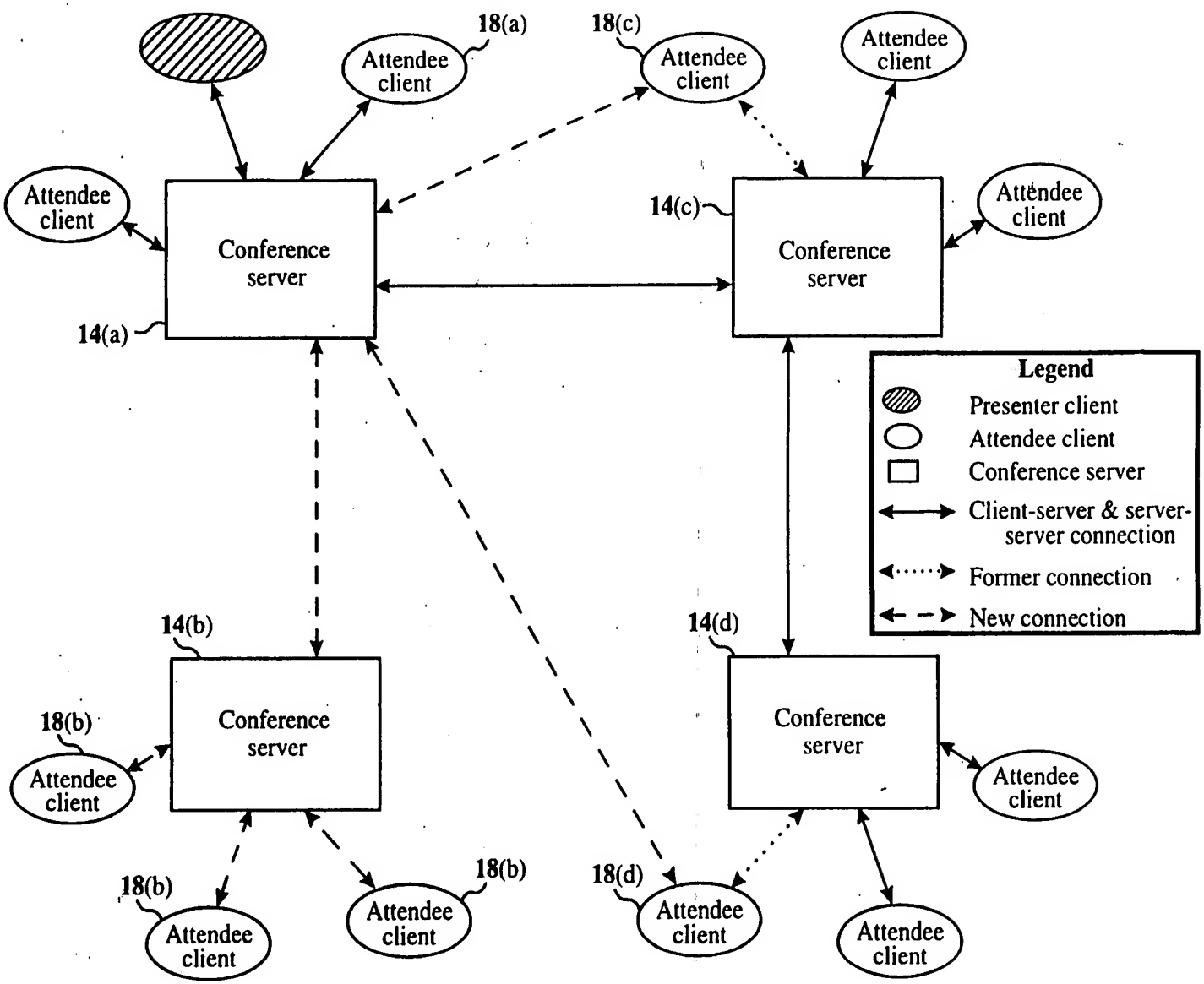

18(a)
18(c)
Attendee client
Attendee client
Attendee client
Attendee client
Attendee client
Conference server
14(a)
14(c)
Conference server
Attendee client
Legend
Presenter client
Attendee client
Conference server
Client-server & server-server connection
Former connection
New connection
14(b)
14(d)
18(b)
Conference server
Conference server
Attendee client
Attendee client
18(b)
18(b)
18(d)
Attendee client
Attendee client
Attendee client
Attendee client

FIG. 9B

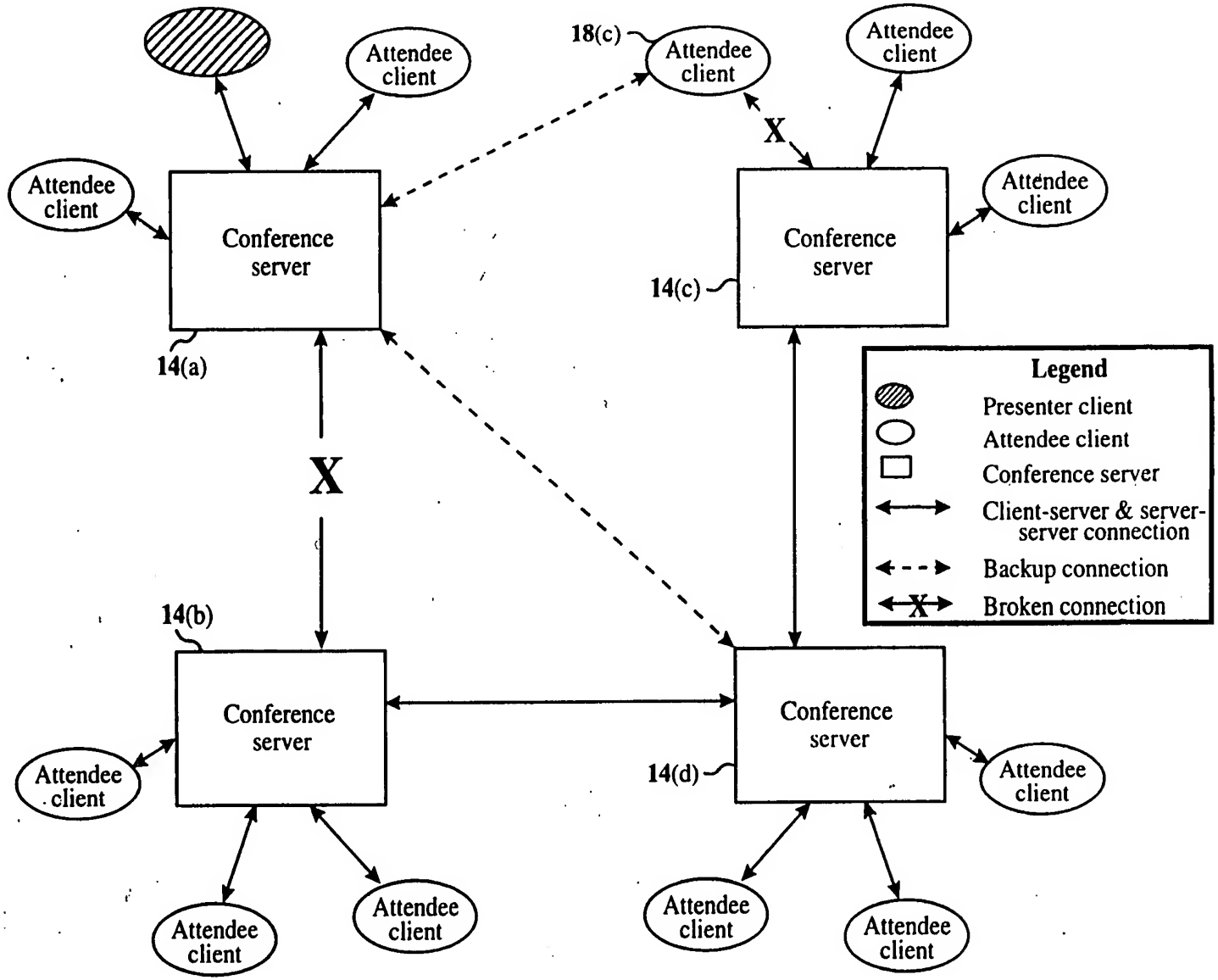

Attendee client
18(c)
Attendee client
Attendee client
X
Attendee client
Attendee client
Conference server
Conference server
14(c)
14(a)
X
Legend
Presenter client
Attendee client
Conference server
Client-server & server-server connection
Backup connection
Broken connection
14(b)
Conference server
Conference server
14(d)
Attendee client
Attendee client
Attendee client
Attendee client
Attendee client

FIG. 9C

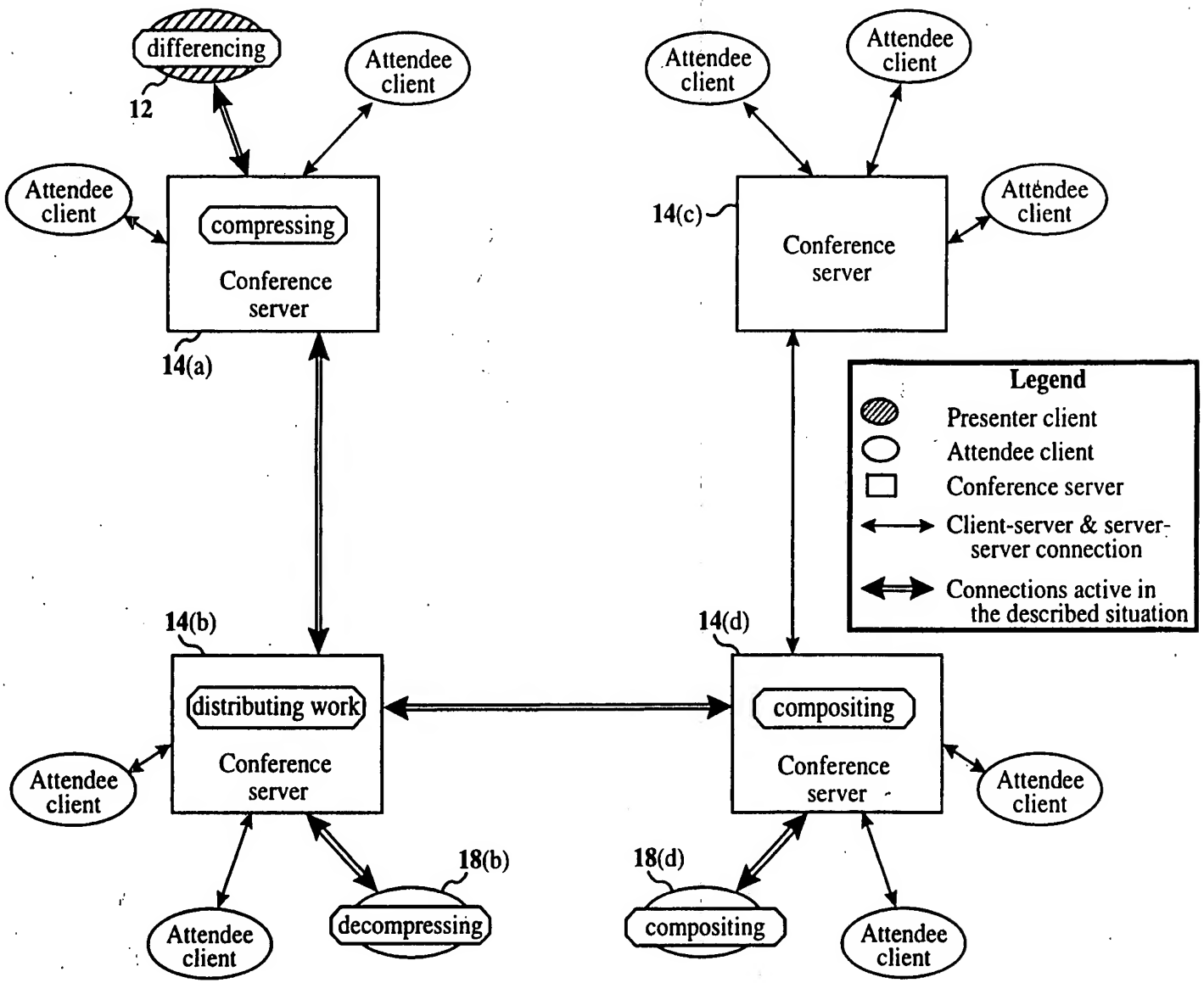

differencing
12
Attendee client
Attendee client
compressing
Conference server
14(a)
Attendee client
Attendee client
Attendee client
14(c)
Conference server
Attendee client
Legend
Presenter client
Attendee client
Conference server
Client-server & server-server connection
Connections active in the described situation
14(b)
14(d)
distributing work
Conference server
compositing
Conference server
Attendee client
Attendee client
18(b)
18(d)
Attendee client
decompressing
compositing
Attendee client

FIG. 9D

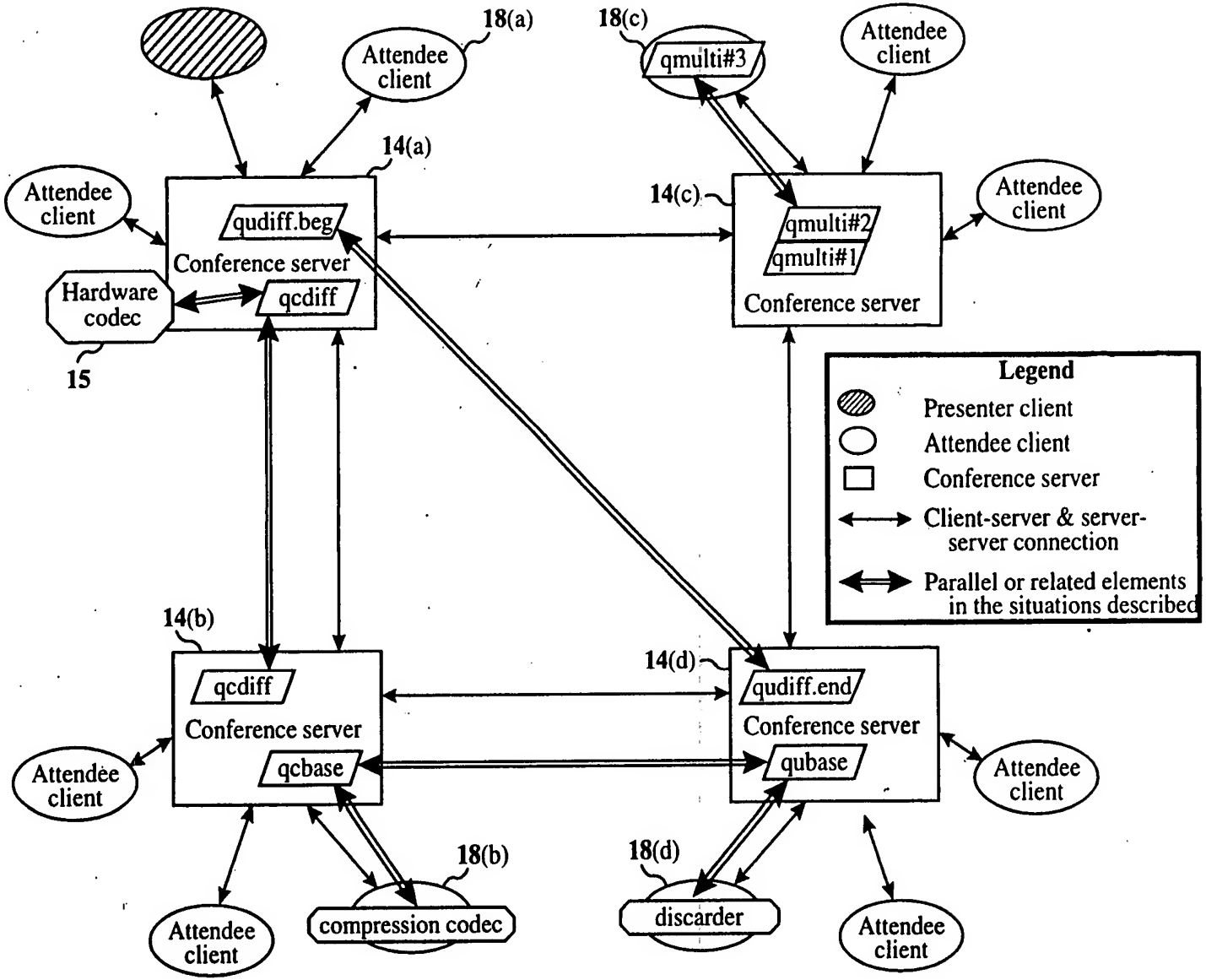

18(a)
Attendee client
18(c)
qmulti#3
Attendee client
14(a)
Attendee client
qudiff.beg
Conference server
Hardware codec
qcdiff
15
14(c)
qmulti#2
qmulti#1
Conference server
Attendee client
Legend
Presenter client
Attendee client
Conference server
Client-server & server-server connection
Parallel or related elements in the situations described
14(b)
qcdiff
Conference server
qcbase
14(d)
qudiff.end
Conference server
qubase
Attendee client
Attendee client
18(b)
18(d)
Attendee client
compression codec
discarder
Attendee client

FIG. 9E

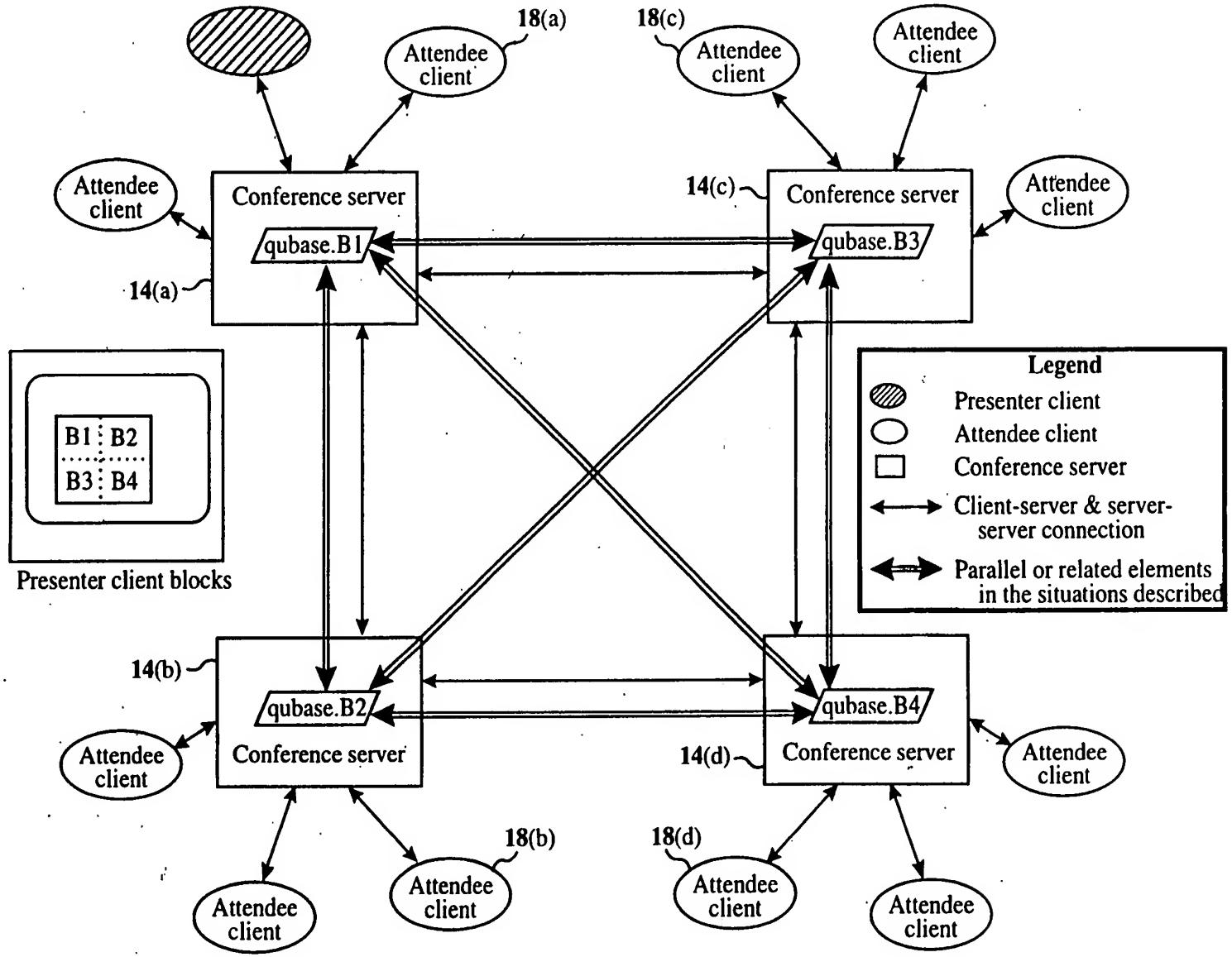

18(a)
Attendee client
18(c)
Attendee client
Attendee client
Attendee client
Conference server
qubase.B1
14(a)
14(c)
Conference server
qubase.B3
Attendee client
B1
B2
B3
B4
Presenter client blocks
Legend
Presenter client
Attendee client
Conference server
Client-server & server-server connection
Parallel or related elements in the situations described
14(b)
qubase.B2
Conference server
qubase.B4
14(d)
Conference server
Attendee client
Attendee client
18(b)
Attendee client
18(d)
Attendee client
Attendee client

FIG. 9F

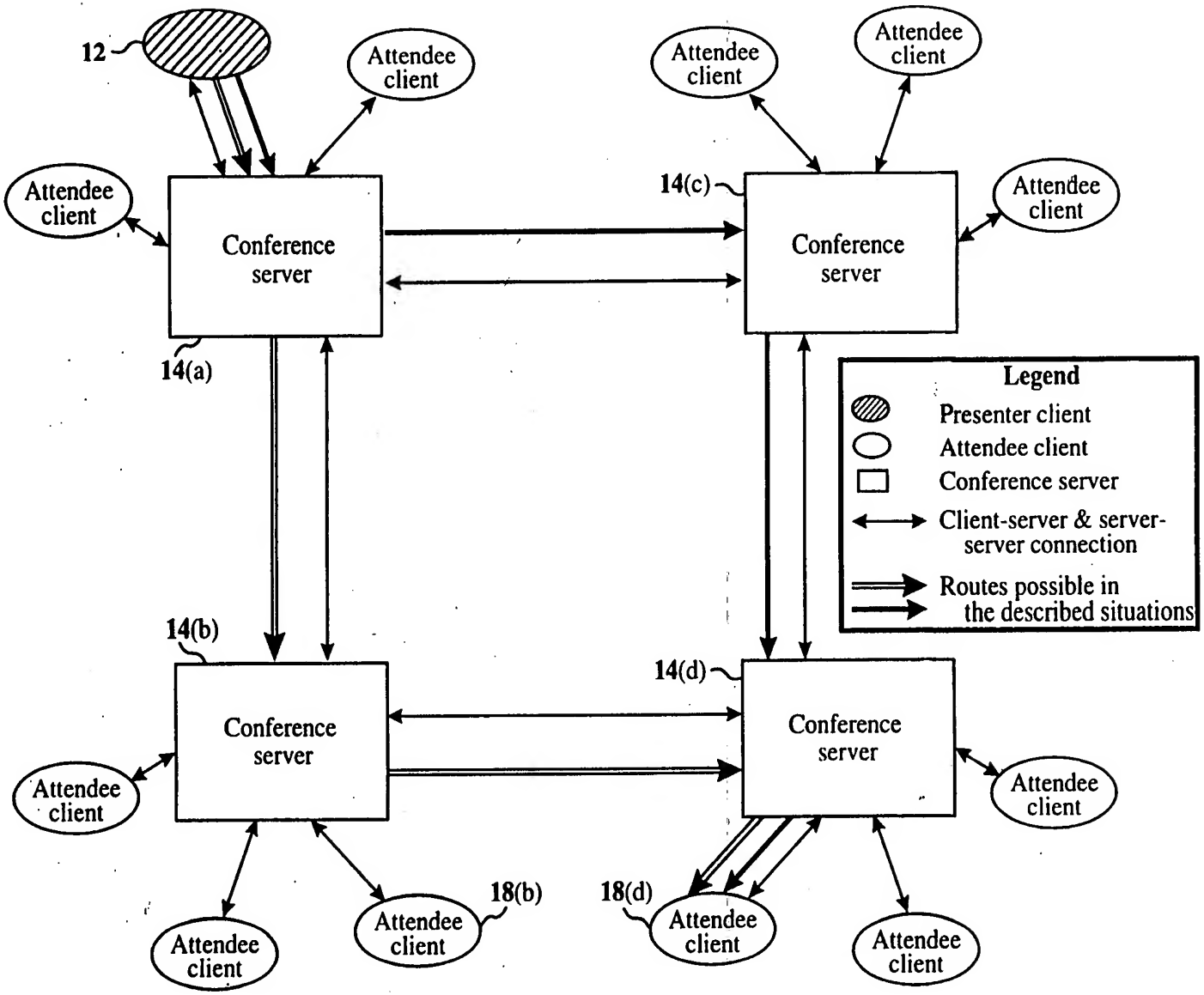

12
Attendee client
Attendee client
Attendee client
Attendee client
Attendee client
14(c)
Conference server
Conference server
14(a)
Legend
Presenter client
Attendee client
Conference server
Client-server & server-server connection
Routes possible in the described situations
14(b)
14(d)
Conference server
Conference server
Attendee client
Attendee client
18(b)
18(d)
Attendee client
Attendee client
Attendee client

FIG. 9G

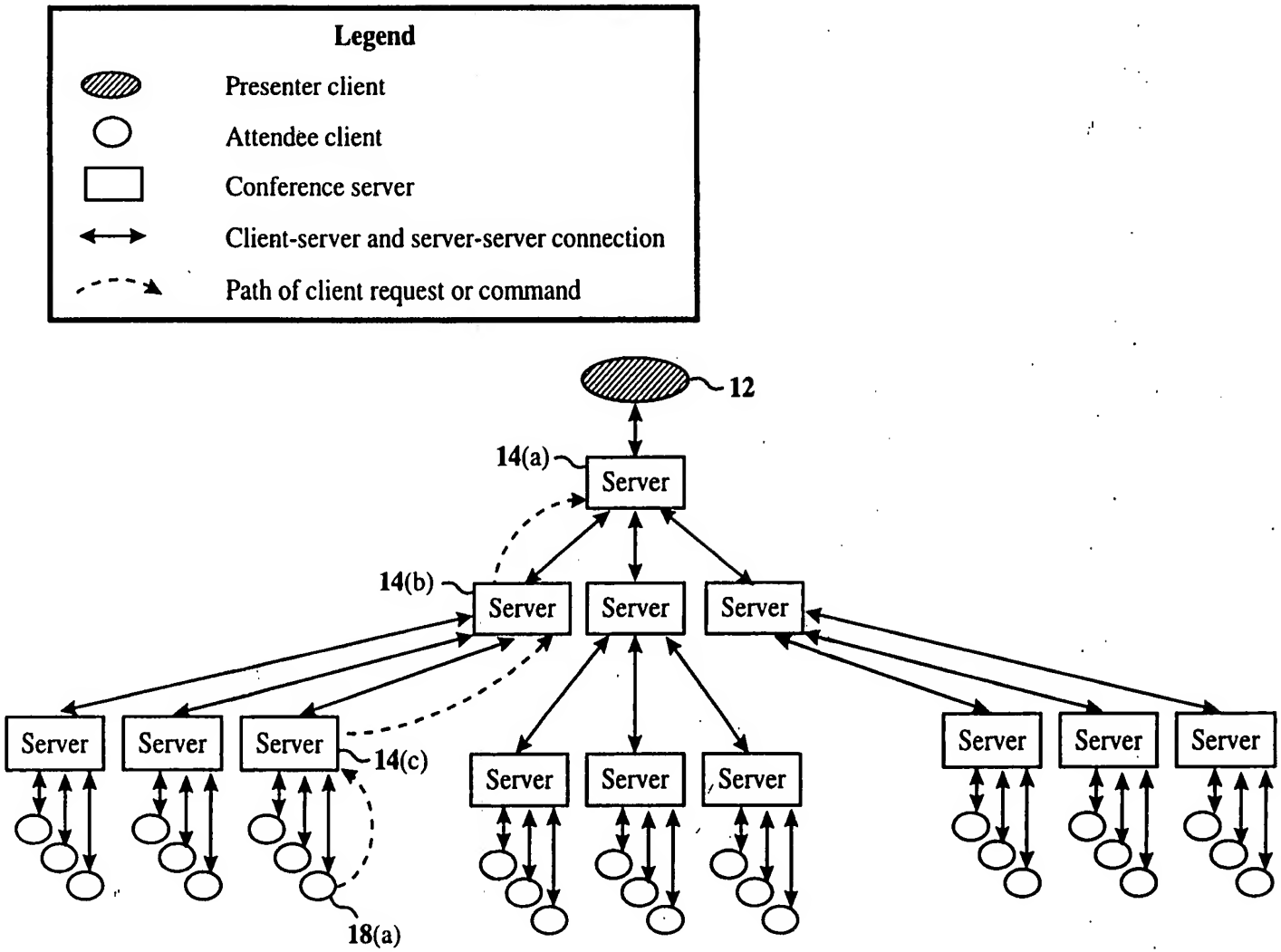

Legend
Presenter client
Attendee client
Conference server
Client-server and server-server connection
Path of client request or command
12
14(a)
Server
14(b)
Server
Server
Server
Server
Server
Server
14(c)
Server
Server
Server
Server
Server
Server
Server
Server
18(a)

FIG. 10A

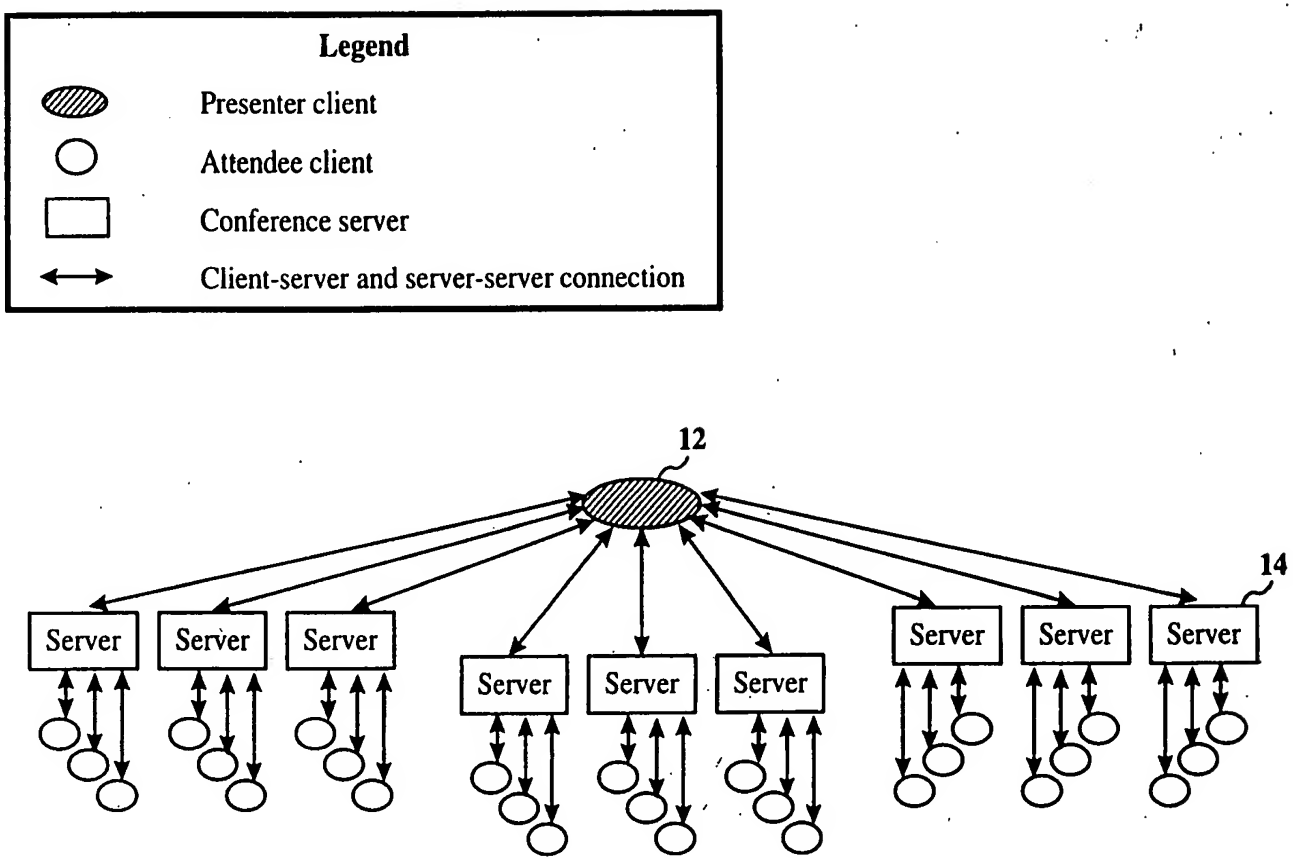

Legend
Presenter client
Attendee client
Conference server
Client-server and server-server connection
12
14
Server
Server
Server
Server
Server
Server
Server
Server
Server

FIG. 10B

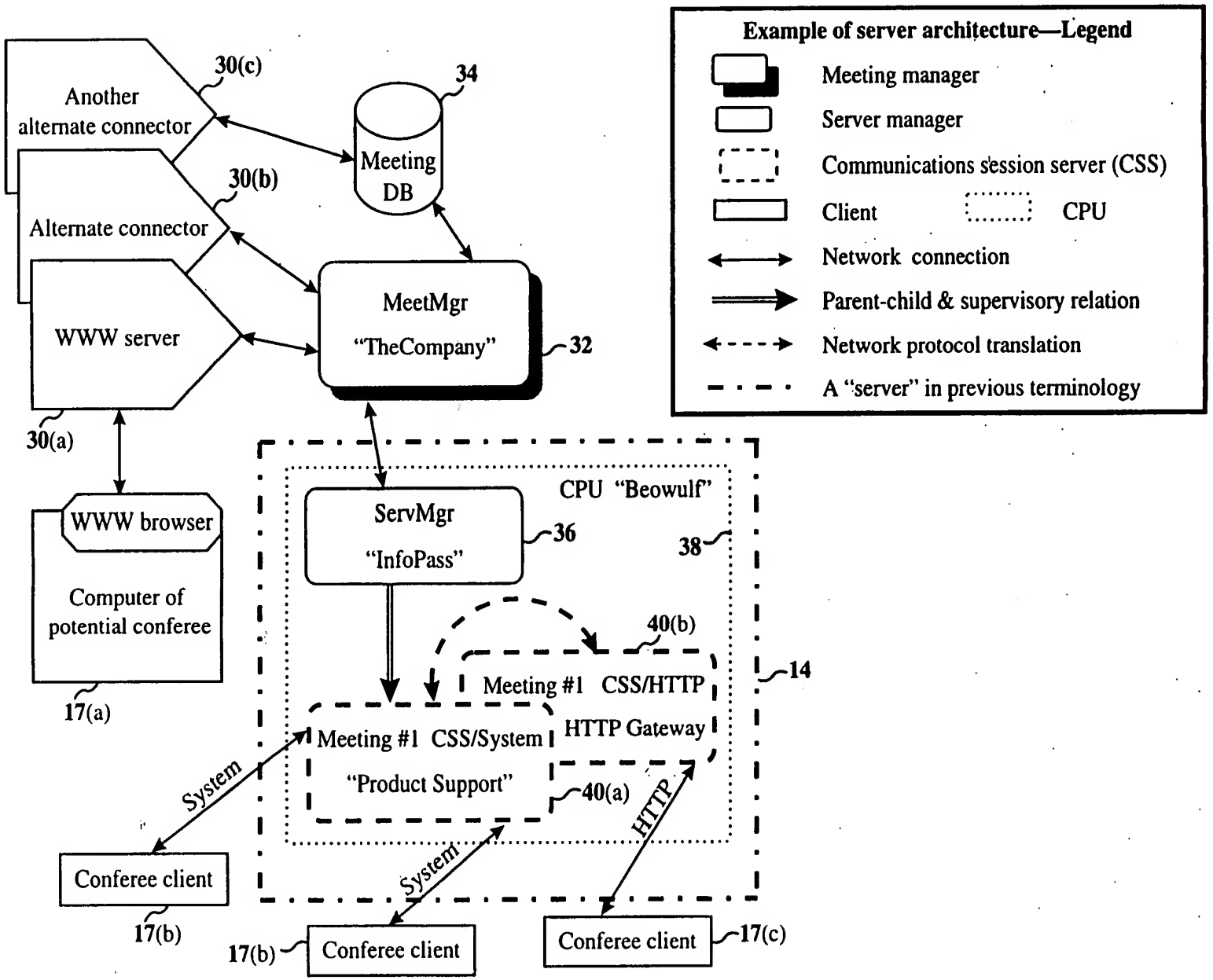

Example of server architecture—Legend
Meeting manager
Server manager
Communications session server (CSS)
Client
CPU
Network connection
Parent-child & supervisory relation
Network protocol translation
A "server" in previous terminology
Another alternate connector
30(c)
34
Meeting DB
30(b)
Alternate connector
WWW server
MeetMgr "TheCompany"
32
30(a)
WWW browser
Computer of potential conferee
17(a)
CPU "Beowulf"
ServMgr "InfoPass"
36
38
40(b)
Meeting #1 CSS/HTTP HTTP Gateway
14
Meeting #1 CSS/System "Product Support"
40(a)
System
HTTP
Conferee client
17(b)
System
17(b)
Conferee client
Conferee client
17(c)

FIG. 11

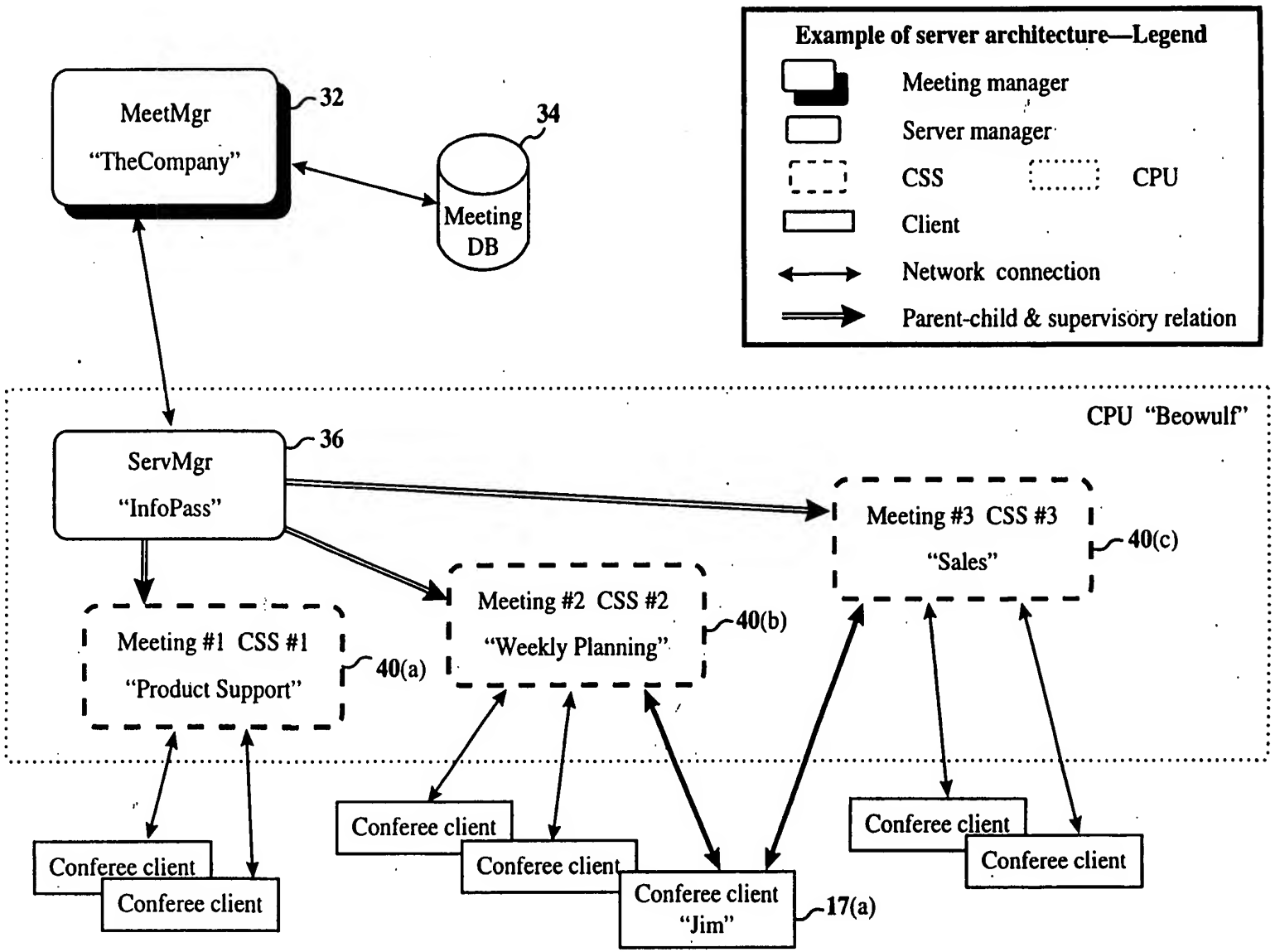

Example of server architecture—Legend
Meeting manager
Server manager
CSS
CPU
Client
Network connection
Parent-child & supervisory relation
MeetMgr
"TheCompany"
32
34
Meeting DB
CPU "Beowulf"
ServMgr
"InfoPass"
36
Meeting #3 CSS #3
"Sales"
40(c)
Meeting #2 CSS #2
"Weekly Planning"
40(b)
Meeting #1 CSS #1
"Product Support"
40(a)
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client
"Jim"
17(a)
Conferee client
Conferee client

FIG. 12

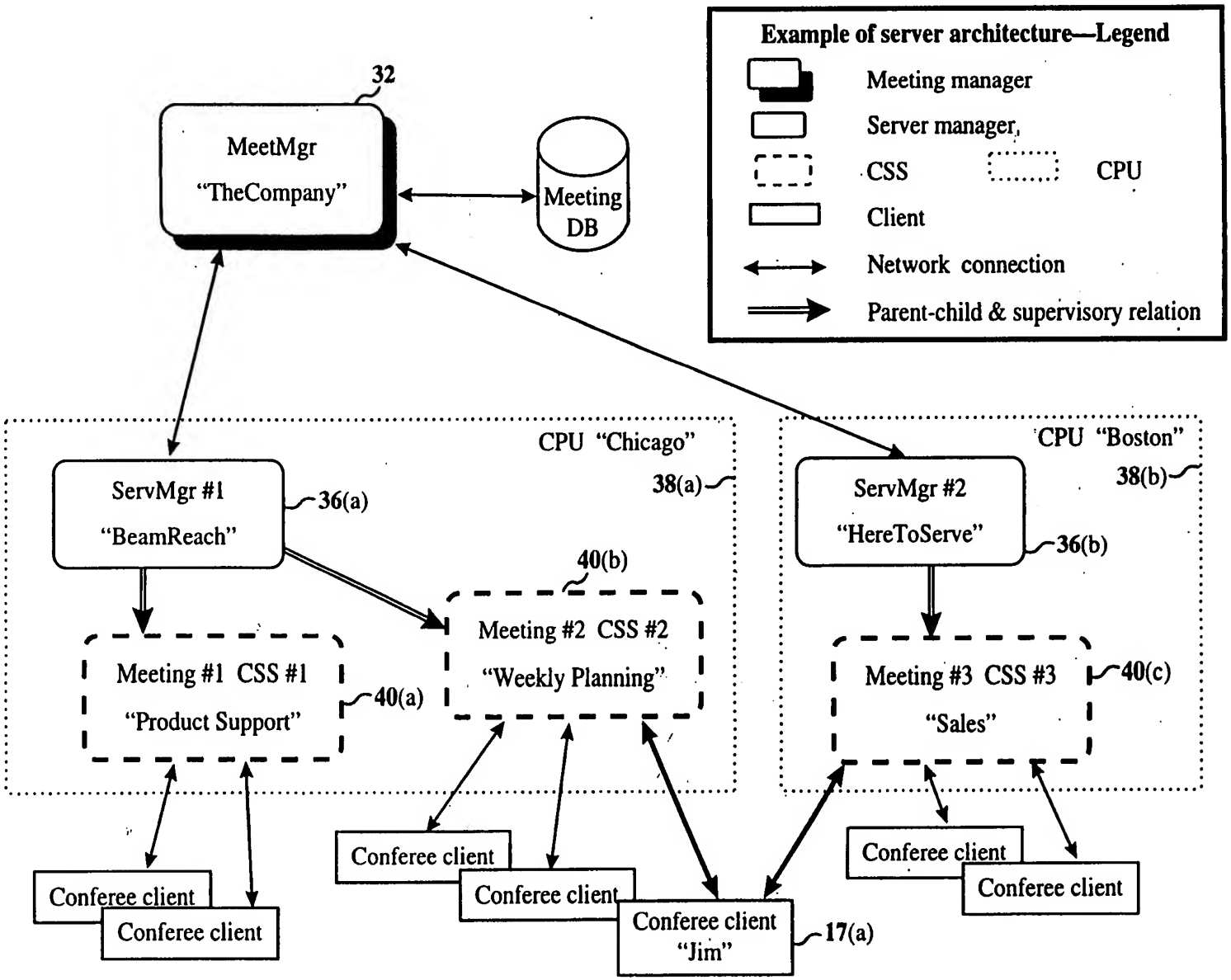

Example of server architecture—Legend
Meeting manager
Server manager
CSS
CPU
Client
Network connection
Parent-child & supervisory relation
32
MeetMgr
"TheCompany"
Meeting DB
CPU "Chicago"
38(a)
ServMgr #1
"BeamReach"
36(a)
40(b)
Meeting #2 CSS #2
"Weekly Planning"
Meeting #1 CSS #1
"Product Support"
40(a)
CPU "Boston"
38(b)
ServMgr #2
"HereToServe"
36(b)
Meeting #3 CSS #3
"Sales"
40(c)
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client
"Jim"
17(a)
Conferee client
Conferee client

FIG. 13

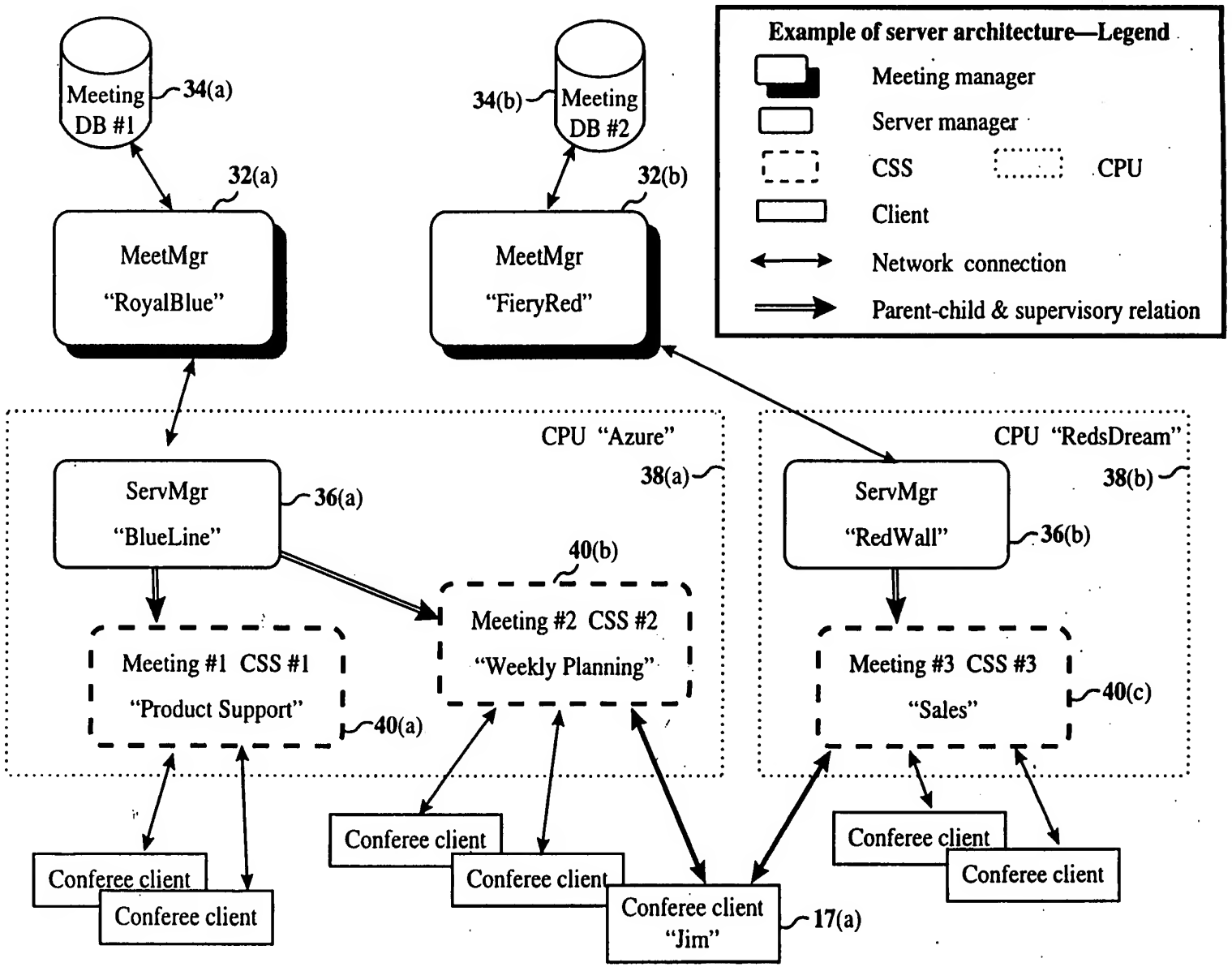

Example of server architecture—Legend
Meeting manager
Server manager
CSS
CPU
Client
Network connection
Parent-child & supervisory relation
Meeting DB #1
34(a)
34(b)
Meeting DB #2
32(a)
32(b)
MeetMgr "RoyalBlue"
MeetMgr "FieryRed"
CPU "Azure"
38(a)
CPU "RedsDream"
38(b)
ServMgr "BlueLine"
36(a)
ServMgr "RedWall"
36(b)
40(b)
Meeting #2 CSS #2 "Weekly Planning"
Meeting #1 CSS #1 "Product Support"
40(a)
Meeting #3 CSS #3 "Sales"
40(c)
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client "Jim"
17(a)

FIG. 14

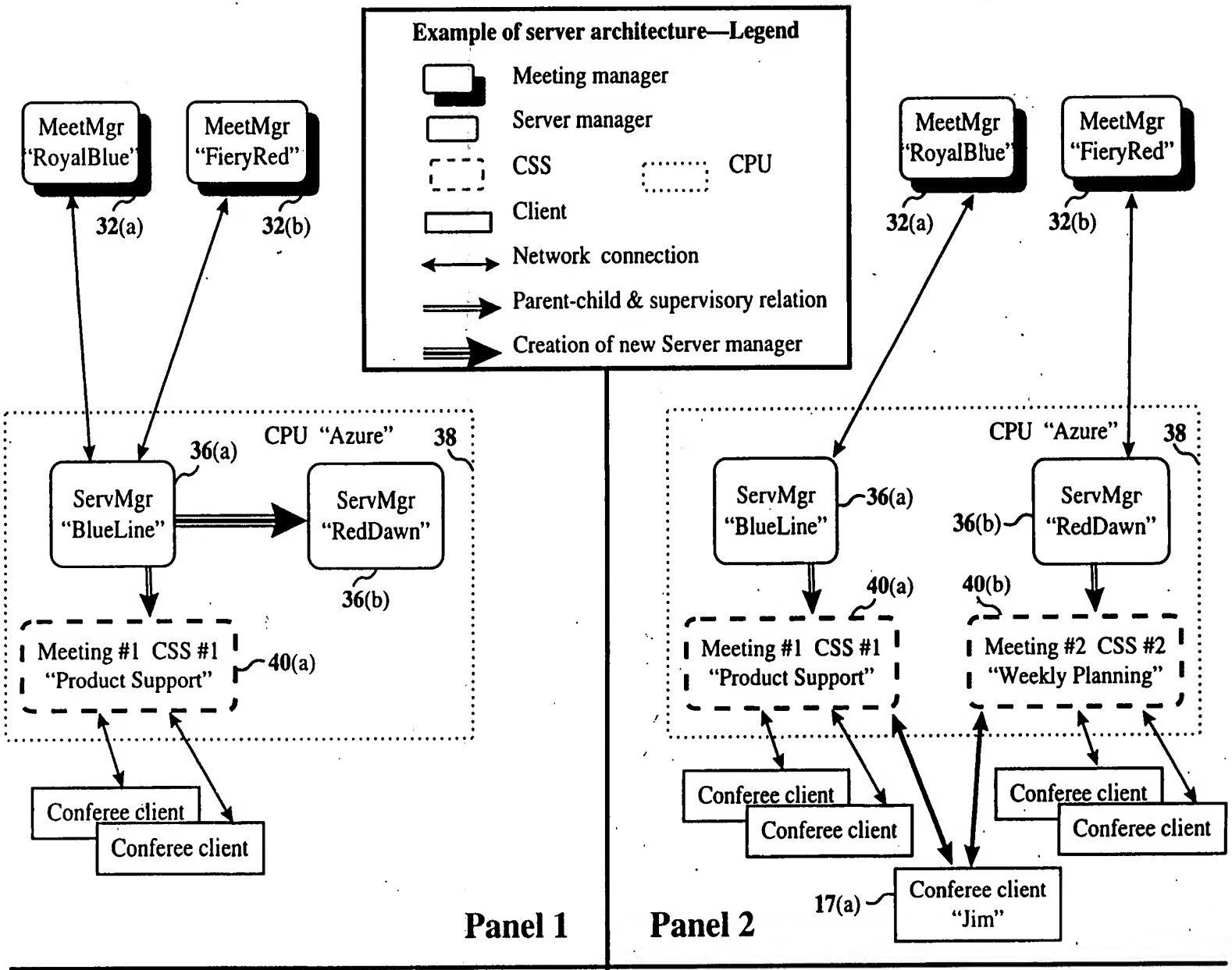

Example of server architecture—Legend
Meeting manager
Server manager
CSS
CPU
Client
Network connection
Parent-child & supervisory relation
Creation of new Server manager
MeetMgr "RoyalBlue"
MeetMgr "FieryRed"
32(a)
32(b)
CPU "Azure"
38
36(a)
ServMgr "BlueLine"
ServMgr "RedDawn"
36(b)
Meeting #1 CSS #1 "Product Support"
40(a)
Conferee client
Conferee client
Panel 1
Panel 2
36(b)
40(a)
40(b)
Meeting #2 CSS #2 "Weekly Planning"
17(a)
Conferee client "Jim"

FIG. 15

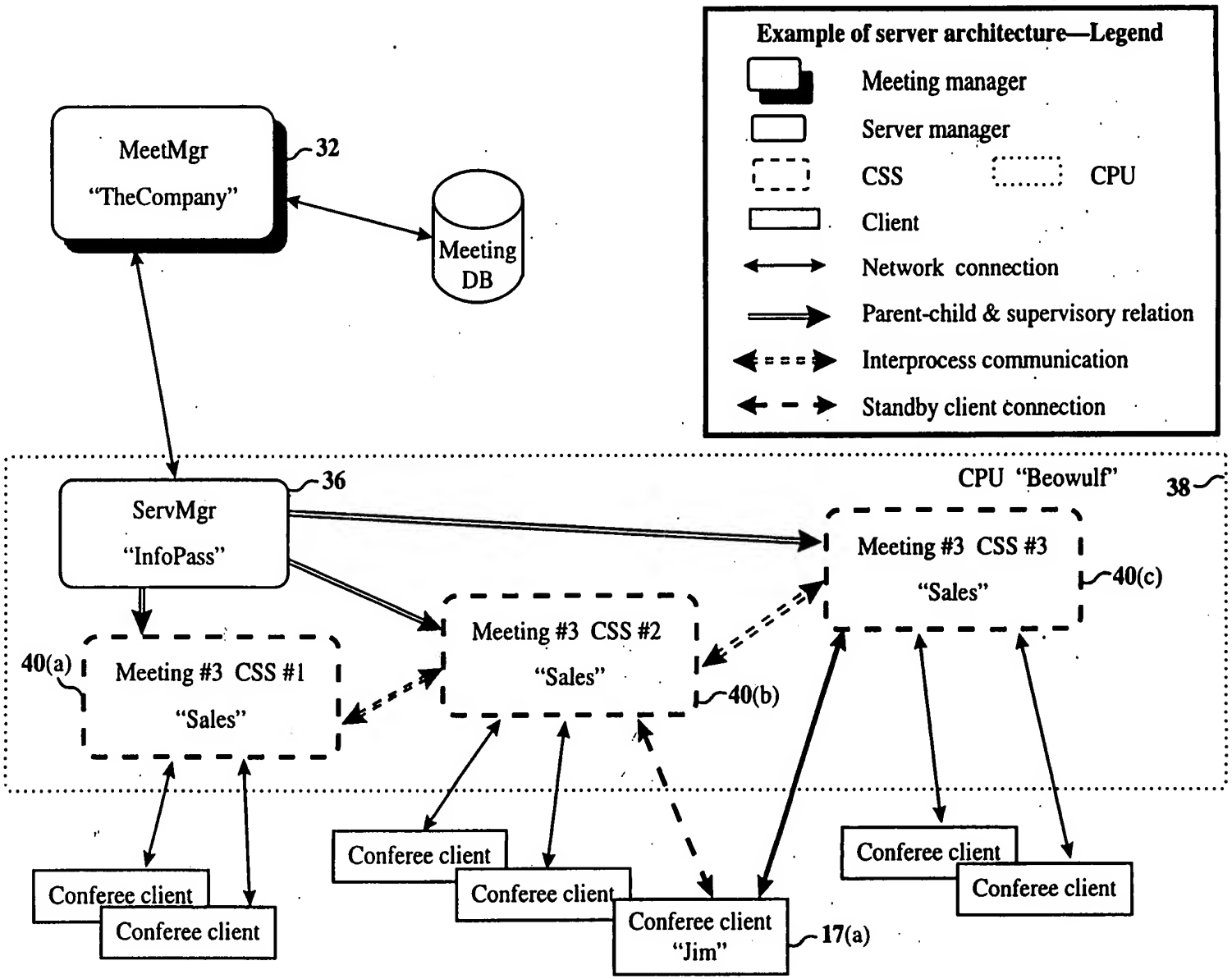

Example of server architecture—Legend
Meeting manager
Server manager
CSS
CPU
Client
Network connection
Parent-child & supervisory relation
Interprocess communication
Standby client connection
MeetMgr
"TheCompany"
32
Meeting DB
CPU "Beowulf"
38
ServMgr
"InfoPass"
36
Meeting #3 CSS #3
"Sales"
40(c)
Meeting #3 CSS #2
"Sales"
40(b)
40(a)
Meeting #3 CSS #1
"Sales"
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client
"Jim"
17(a)
Conferee client
Conferee client

FIG. 16

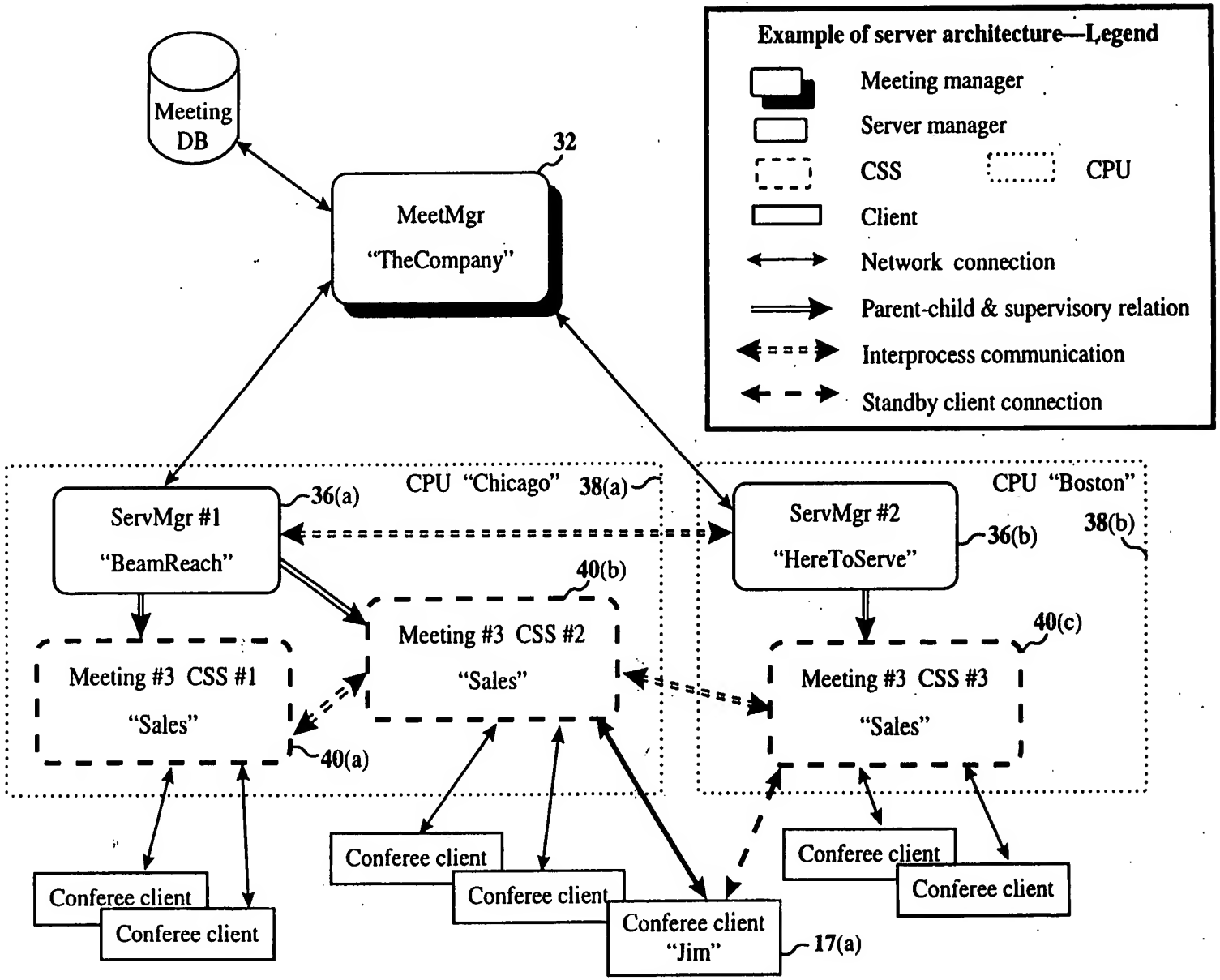

Example of server architecture—Legend
Meeting manager
Server manager
CSS
CPU
Client
Network connection
Parent-child & supervisory relation
Interprocess communication
Standby client connection
Meeting DB
32
MeetMgr
"TheCompany"
CPU "Chicago"
38(a)
CPU "Boston"
38(b)
ServMgr #1
"BeamReach"
36(a)
ServMgr #2
"HereToServe"
36(b)
40(b)
Meeting #3 CSS #2
"Sales"
40(c)
Meeting #3 CSS #1
"Sales"
40(a)
Meeting #3 CSS #3
"Sales"
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client
"Jim"
17(a)

FIG. 17

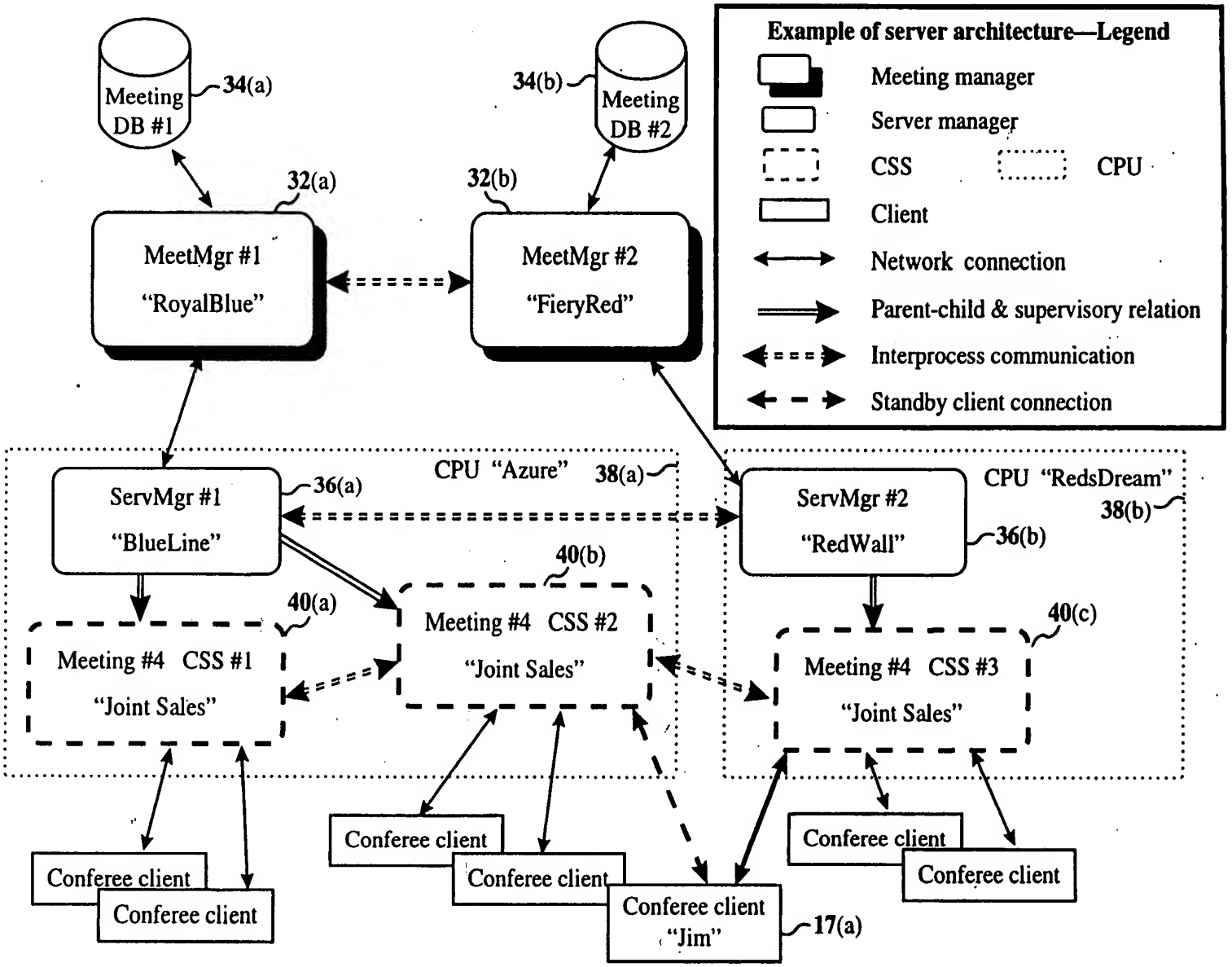

Example of server architecture—Legend
Meeting manager
Server manager
CSS
CPU
Client
Network connection
Parent-child & supervisory relation
Interprocess communication
Standby client connection
Meeting DB #1
34(a)
34(b)
Meeting DB #2
32(a)
32(b)
MeetMgr #1
"RoyalBlue"
MeetMgr #2
"FieryRed"
CPU "Azure"
38(a)
CPU "RedsDream"
38(b)
ServMgr #1
"BlueLine"
36(a)
ServMgr #2
"RedWall"
36(b)
40(b)
40(a)
40(c)
Meeting #4 CSS #1
"Joint Sales"
Meeting #4 CSS #2
"Joint Sales"
Meeting #4 CSS #3
"Joint Sales"
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client
"Jim"
17(a)
Conferee client
Conferee client

FIG. 18

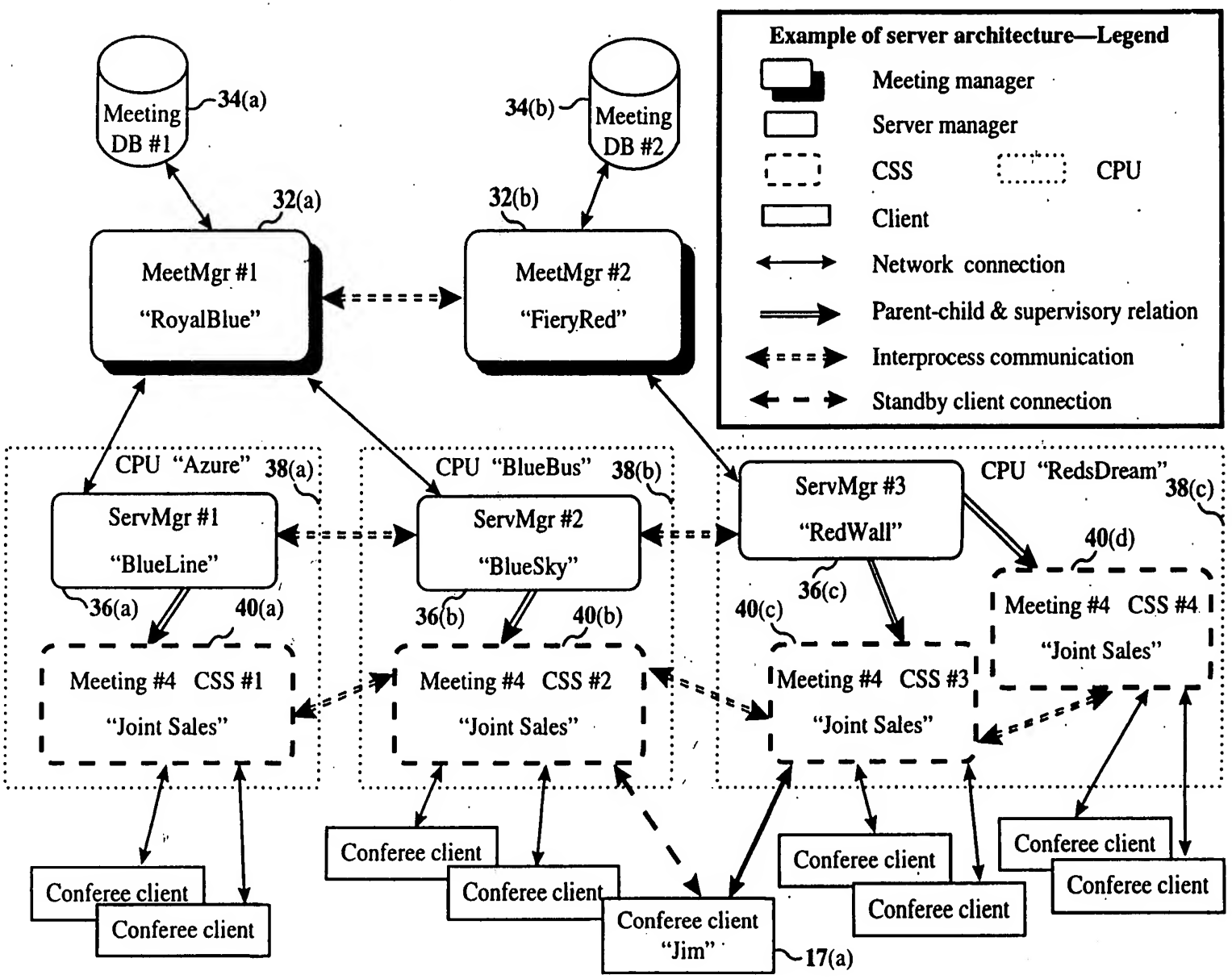

Example of server architecture—Legend
Meeting manager
Server manager
CSS
CPU
Client
Network connection
Parent-child & supervisory relation
Interprocess communication
Standby client connection
Meeting DB #1
34(a)
34(b)
Meeting DB #2
32(a)
32(b)
MeetMgr #1
"RoyalBlue"
MeetMgr #2
"FieryRed"
CPU "Azure"
38(a)
CPU "BlueBus"
38(b)
CPU "RedsDream"
38(c)
ServMgr #1
"BlueLine"
ServMgr #2
"BlueSky"
ServMgr #3
"RedWall"
40(d)
36(a)
40(a)
36(b)
40(b)
36(c)
40(c)
Meeting #4 CSS #1
"Joint Sales"
Meeting #4 CSS #2
"Joint Sales"
Meeting #4 CSS #3
"Joint Sales"
Meeting #4 CSS #4
"Joint Sales"
Conferee client
Conferee client
Conferee client
Conferee client
Conferee client
"Jim"
17(a)
Conferee client
Conferee client
Conferee client
Conferee client

FIG. 19

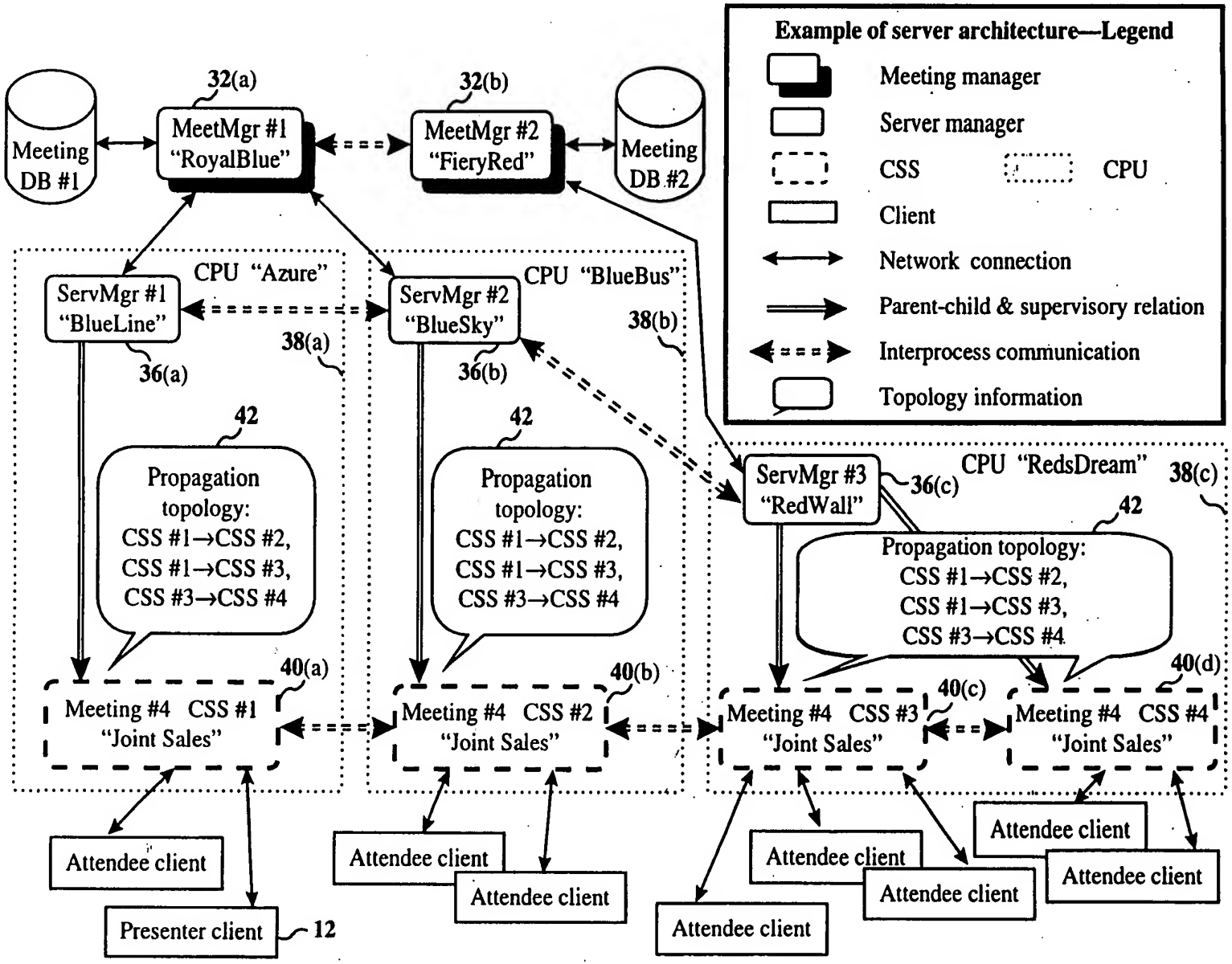

Example of server architecture—Legend
Meeting manager
Server manager
CSS
CPU
Client
Network connection
Parent-child & supervisory relation
Interprocess communication
Topology information
Meeting DB #1
32(a)
MeetMgr #1 "RoyalBlue"
32(b)
MeetMgr #2 "FieryRed"
Meeting DB #2
CPU "Azure"
ServMgr #1 "BlueLine"
36(a)
38(a)
CPU "BlueBus"
ServMgr #2 "BlueSky"
36(b)
38(b)
ServMgr #3 "RedWall"
36(c)
CPU "RedsDream"
38(c)
42
Propagation topology: CSS #1→CSS #2, CSS #1→CSS #3, CSS #3→CSS #4
40(a)
Meeting #4 CSS #1 "Joint Sales"
40(b)
Meeting #4 CSS #2 "Joint Sales"
40(c)
Meeting #4 CSS #3 "Joint Sales"
40(d)
Meeting #4 CSS #4 "Joint Sales"
Attendee client
Presenter client
12

FIG. 20

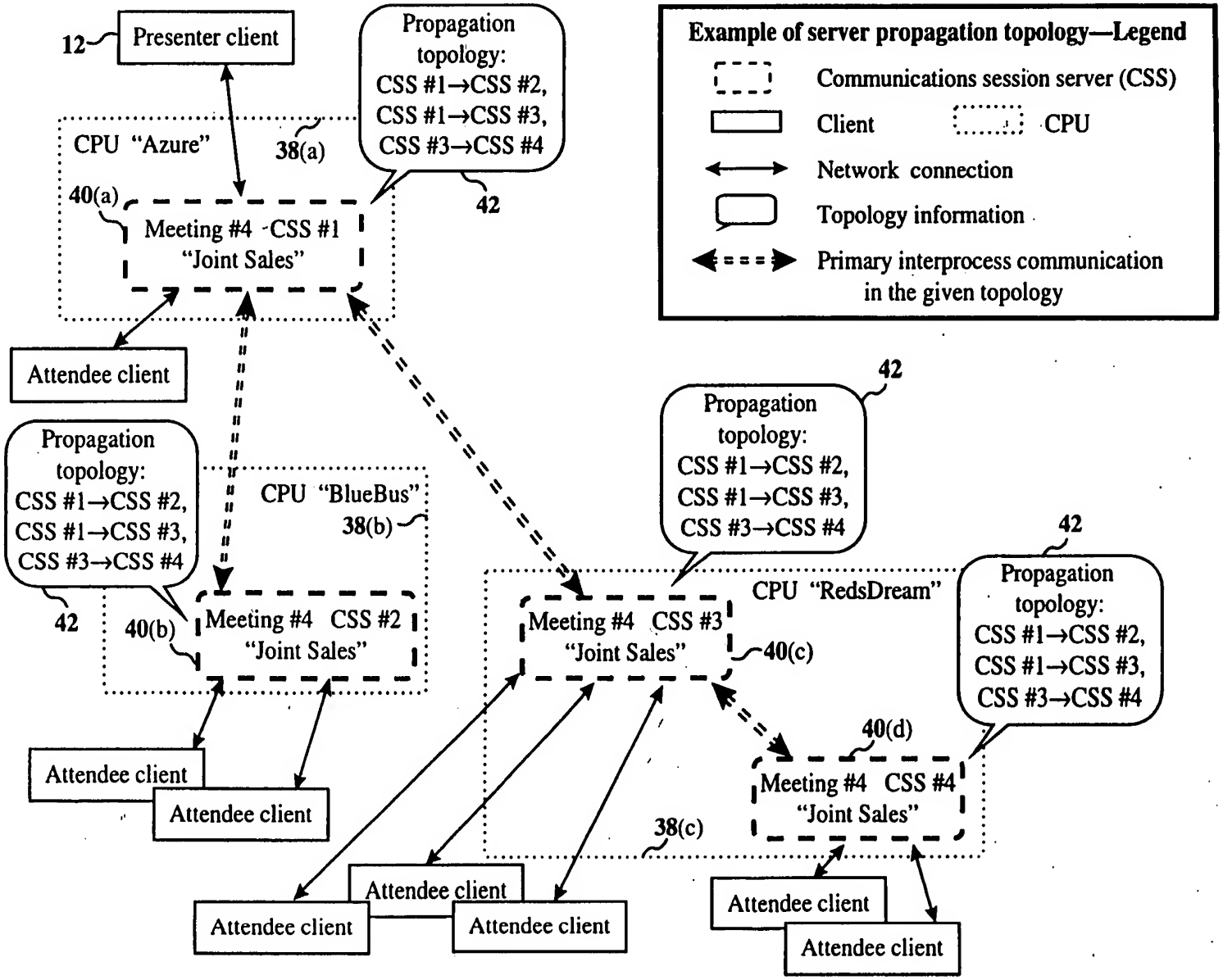

Example of server propagation topology—Legend
Communications session server (CSS)
Client
CPU
Network connection
Topology information
Primary interprocess communication in the given topology
12
Presenter client
Propagation topology: CSS #1→CSS #2, CSS #1→CSS #3, CSS #3→CSS #4
42
CPU "Azure"
38(a)
40(a)
Meeting #4 CSS #1 "Joint Sales"
Attendee client
Propagation topology: CSS #1→CSS #2, CSS #1→CSS #3, CSS #3→CSS #4
42
CPU "BlueBus"
38(b)
40(b)
Meeting #4 CSS #2 "Joint Sales"
Attendee client
Attendee client
42
Propagation topology: CSS #1→CSS #2, CSS #1→CSS #3, CSS #3→CSS #4
CPU "RedsDream"
Meeting #4 CSS #3 "Joint Sales"
40(c)
42
Propagation topology: CSS #1→CSS #2, CSS #1→CSS #3, CSS #3→CSS #4
40(d)
Meeting #4 CSS #4 "Joint Sales"
38(c)
Attendee client
Attendee client
Attendee client
Attendee client
Attendee client

FIG. 21

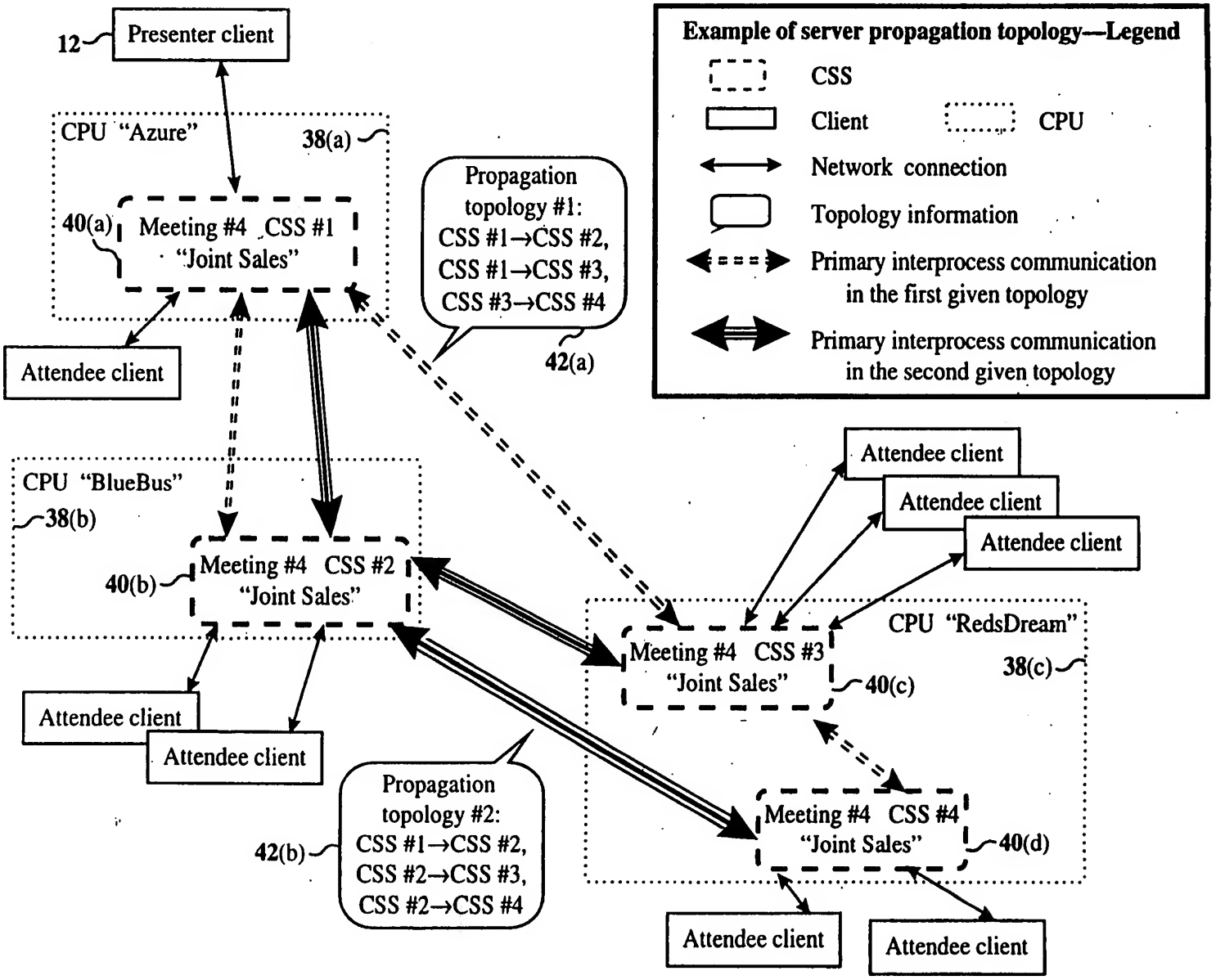
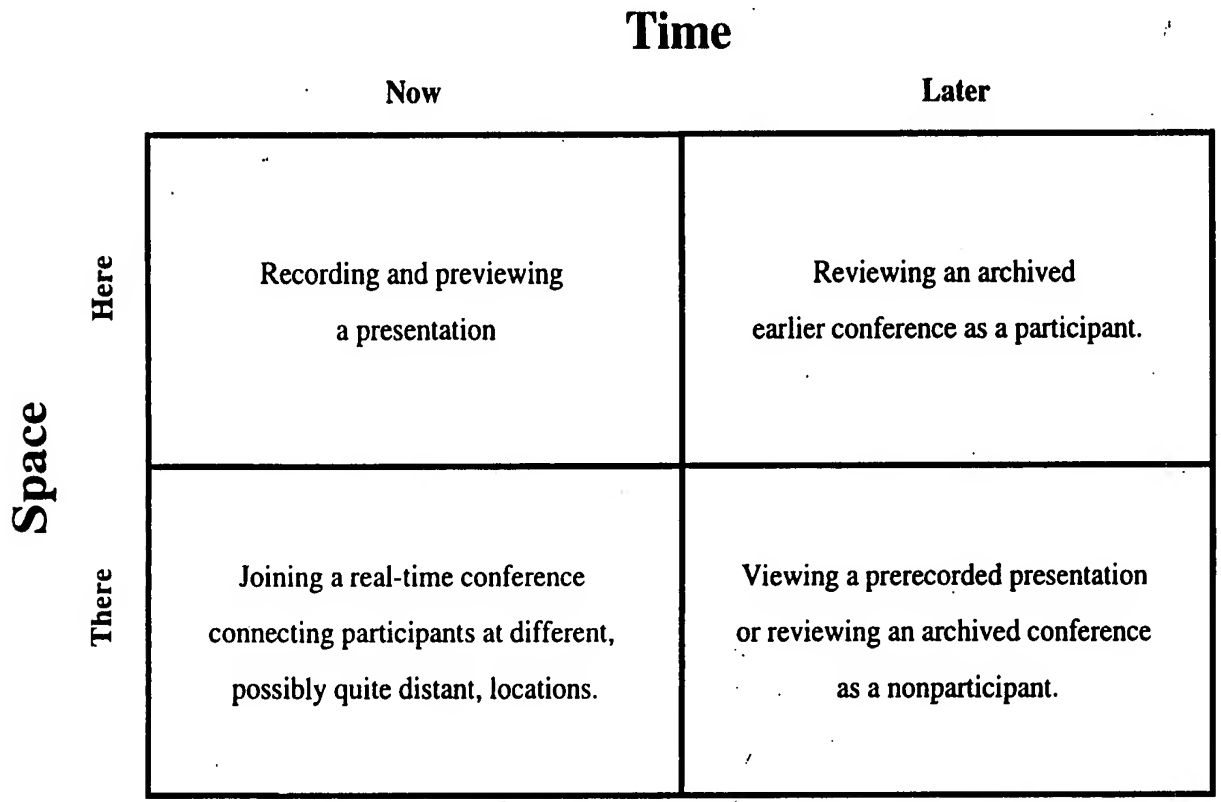

Example of server propagation topology—Legend
CSS
Client
CPU
Network connection
Topology information
Primary interprocess communication in the first given topology
Primary interprocess communication in the second given topology
12
Presenter client
CPU "Azure"
38(a)
40(a)
Meeting #4 CSS #1
"Joint Sales"
Attendee client
Propagation topology #1:
CSS #1→CSS #2,
CSS #1→CSS #3,
CSS #3→CSS #4
42(a)
CPU "BlueBus"
38(b)
40(b)
Meeting #4 CSS #2
"Joint Sales"
Attendee client
Attendee client
Attendee client
Attendee client
Attendee client
CPU "RedsDream"
38(c)
Meeting #4 CSS #3
"Joint Sales"
40(c)
Meeting #4 CSS #4
"Joint Sales"
40(d)
Attendee client
Attendee client
Propagation topology #2:
CSS #1→CSS #2,
CSS #2→CSS #3,
CSS #2→CSS #4
42(b)

FIG. 22



Time vs. Space diagram of some system applications

FIG. 23